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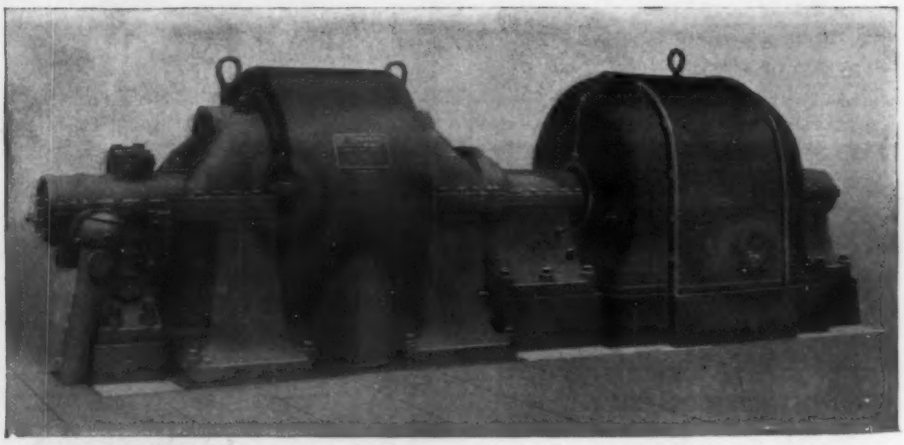

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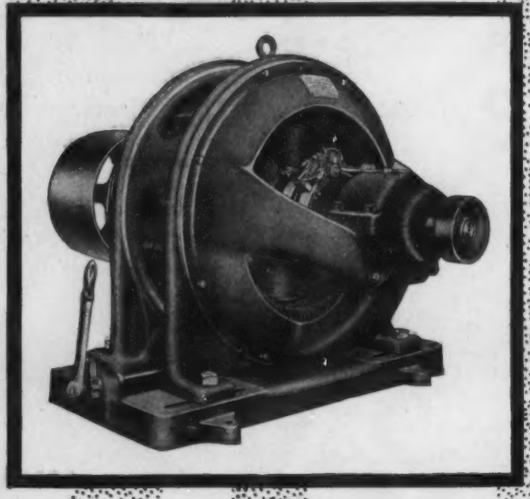

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POWER AND GAS
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STATION "G," SAN FRANCISCO

BY C. F. ADAMS.[1]

Out in the district north of Golden Gate Park a temporary substation was built four years ago. San Francisco emerging from many ashes and some sackcloth would have amusement and the Chutes Park wanted light and power. A residence district also was building which required service.

To follow this shifting population the Chutes Park has moved to Fillmore street, and its old leased location has been sold to home builders. Thus it came that the Chutes substation was obsolete and required a new and more effective location. A careful survey was made of the territory west of Fillmore street, and a

Exterior Station G.

Four years ago a prophecy as to the city's future was by no means unanimous, and temporary construction was sometimes advisable. With this in mind a steel frame and galvanized steel structure was erected, large enough to supply present local conditions. In the four years that have elapsed, changes were many. Van Ness avenue has ceased to be a business street, the down-town district having been rebuilt and reoccupied. The congestion in and about Fillmore street has been relieved, and the entire center of population has shifted. Also the load center of the gas and electric service has shifted.

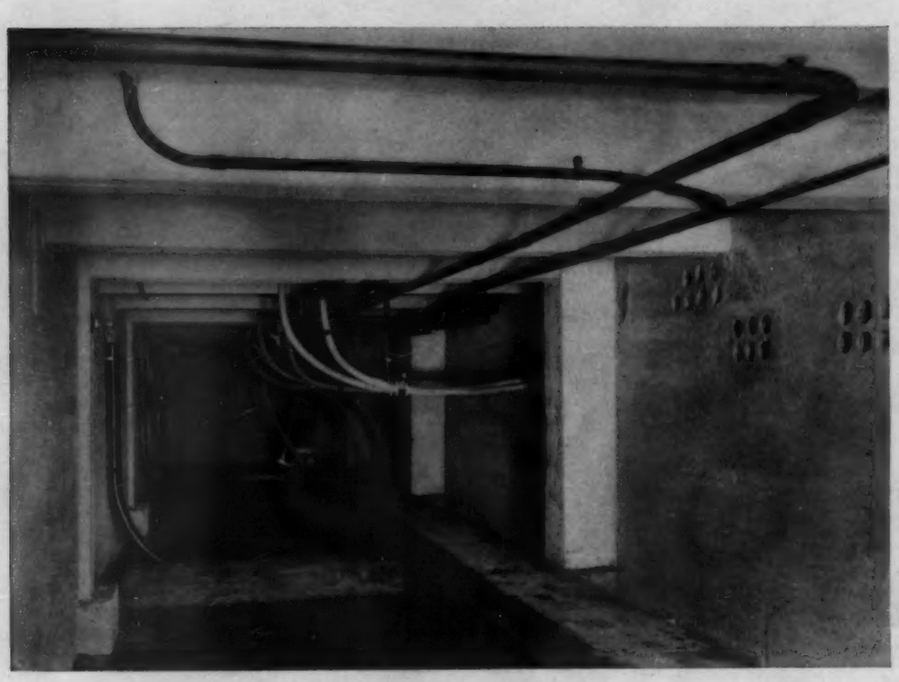
location was finally secured on the northeast corner of Ellis and Broderick streets. This was in a residential section and plans were drawn for a station that would not be out of harmony with its surroundings.

The station is unique in some respects. It does not contain a single window in its four concrete walls, light and ventilation being obtained from a long overhead skylight and louvre. A large panelled oak door is the central feature of the front wall. The architectural design is pleasing and is well pictured in the illustrations.

The building is constructed of reinforced concrete throughout. Within the building every convenience is provided for the safe control of the equipment. A

[1]Engineer of Electric Construction, Pacific Gas and Electric Company.

Main floor—showing switchboard and voltage regulators.



Subway beneath switchboard.

gallery supports the concrete switch cells which contain the 11,000-volt bus, oil switches, and current transformers. A twenty-ton traveling crane spans the main floor and permits quick removal of any heavy apparatus. The switchboard is on the main floor along the line of gallery columns. The 2300-volt two-phase switching equipment and bus is beneath the gallery floor and directly back of switchboard. A roomy subway gives access to all the operating mechanisms, cable and conduit outlets. Three thousand kilowatts capacity of transformers is at present installed with voltage regulators for four circuits.

TRANSMISSION APPLIED TO IRRIGATION.[1]

BY O. H. ENSIGN AND J. M. GAYLORD

The subject of transmission applied to irrigation covers a very broad field of electrical, hydraulic and mechanical engineering. It presents problems of finance and agriculture and must also be viewed from the humanitarian standpoint. There are a number of distinct conditions which lead to the use of transmitted power for pumping in connection with irrigation projects. The more important of these conditions are the following:

1. In some cases high lands which can not be reached by the diversion works constructed for a gravity system can be reached by pumping water from the gravity canals into canals feeding such high land areas.

2. The irrigated area may be advantageously extended by pumping from wells, thus drawing on the underground sources and tending to keep the water plane down, this plan being particularly desirable in certain cases, as will be explained farther on in this article.

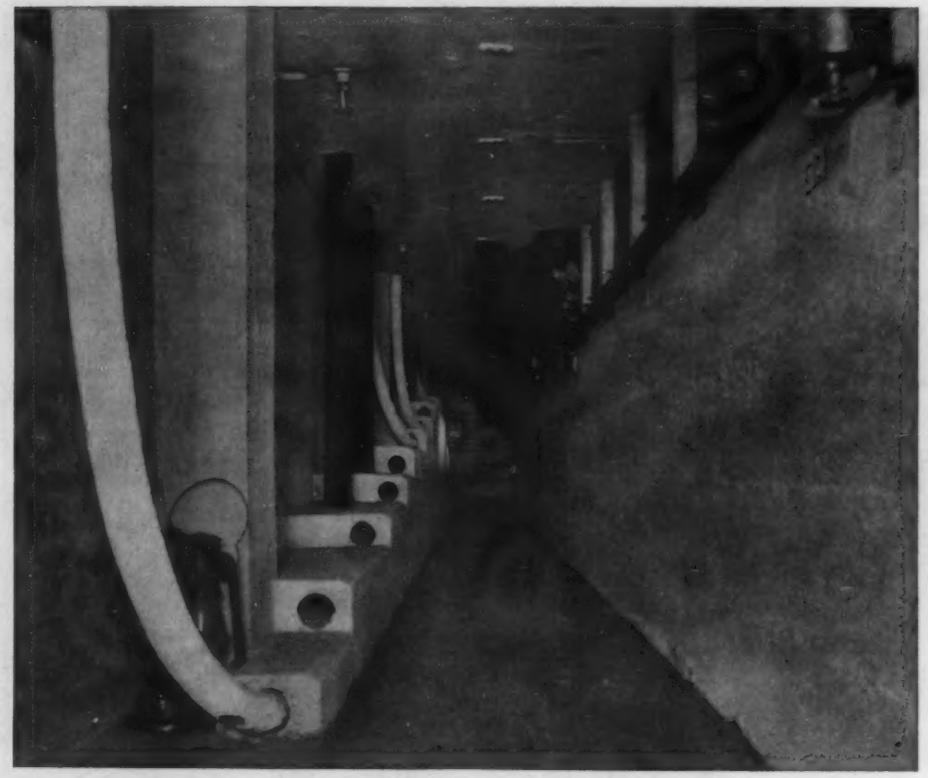
3. Pumping may also be applied to the drainage of low land, water being pumped to either irrigation or waste ditches.

In connection with the diversion works, it frequently occurs that a considerable amount of hydraulic power can be developed.

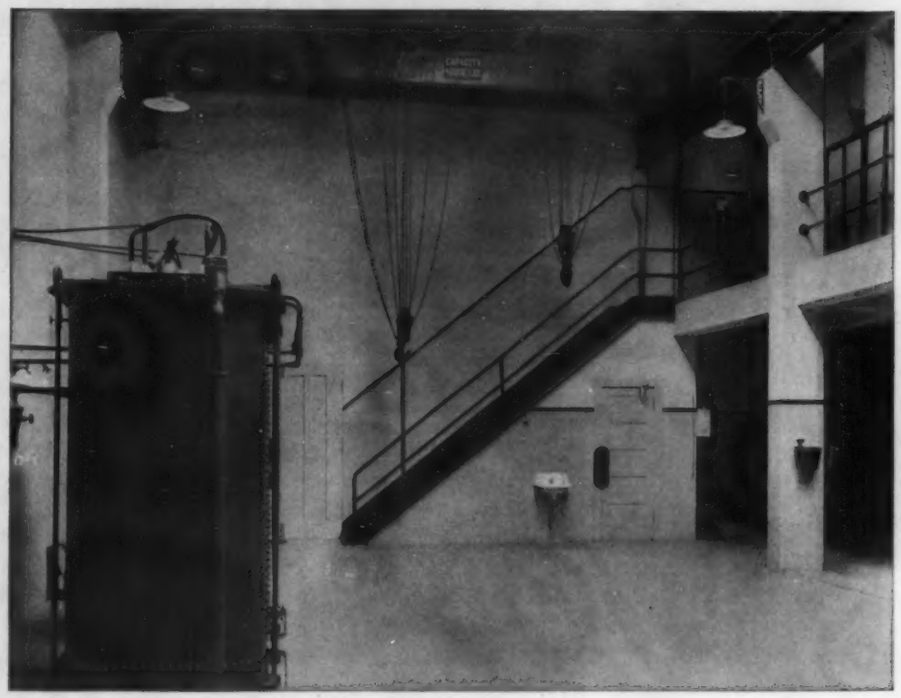
This paper will be devoted mainly to the discussion of a hydroelectric transmission system constructed by the Reclamation Service applied to the irrigation of high lands by pumping from gravity canals.

It may not be inappropriate in this discussion to call attention to the advantages of pumping the ground waters of an irrigated area. The advantages of such a plan are, first, to prevent the rise of the ground waters to a point dangerously near the surface and, second, to supplement by means of drawing on the underground supplies the water stored in the reservoir or diverted from the natural flow of the streams.

[1]Abstract from paper presented at the Pacific Coast Meeting of the American Institute of Electrical Engineers, Los Angeles, April 25-28, 1911.



Passageway back of switch-cells, showing cable outlets and switch operators.



North end of station, showing gallery stairway.

The rise of the ground waters damages the land in an arid climate by allowing evaporation to take place from the surface or from near the surface of the ground, thus increasing the amount of deleterious salts in the surface soil, gradually causing the land to become alkaline in character and non-productive, hence it is essential that the water plane should not rise beyond a certain limit.

It may generally be considered that the thorough watering for irrigation purposes of a large area of land which heretofore has been drained by the rivers which have flowed through it will tend more or less to cause a rise of the ground waters, hence the importance of this particular phase of irrigation.

In some cases the natural underground drainage may be such that the rise of the water plane will be limited to a reasonable depth below the surface, but there are many examples in the West where this has not been the case and lands which were once unusually productive have been made valueless on account of the rise of the water plane. In some instances it may be necessary to drain this water off and let it waste, because it may carry a percentage of salts that would damage the land, but in the majority of cases it may be pumped from wells into canals and distributed.

Southern California presents a good example of this condition, for practically two-thirds of the water supply for this wonderfully productive area is obtained from underground sources. The water plane in a large section of this area is maintained at least 50 ft. below the surface of the ground, thus giving good drainage and constantly improving the condition of the surface soil. All of this pumped water is used for irrigation.

In all irrigation projects, whether by gravity or pumping, the first thing to be borne in mind is will it pay; that is, can the land stand the charge for the development and the cost of operation of the same. Here the question of climate and the class of products which can be raised upon the soil must be taken into consideration. In some localities a cost of $40 per acre would be a limiting price for the development. In other cases a charge of $100 per acre would not be excessive. The charge for maintenance and operation may vary from $2 to $25 or $30 per acre per annum, the nature of the crop being the

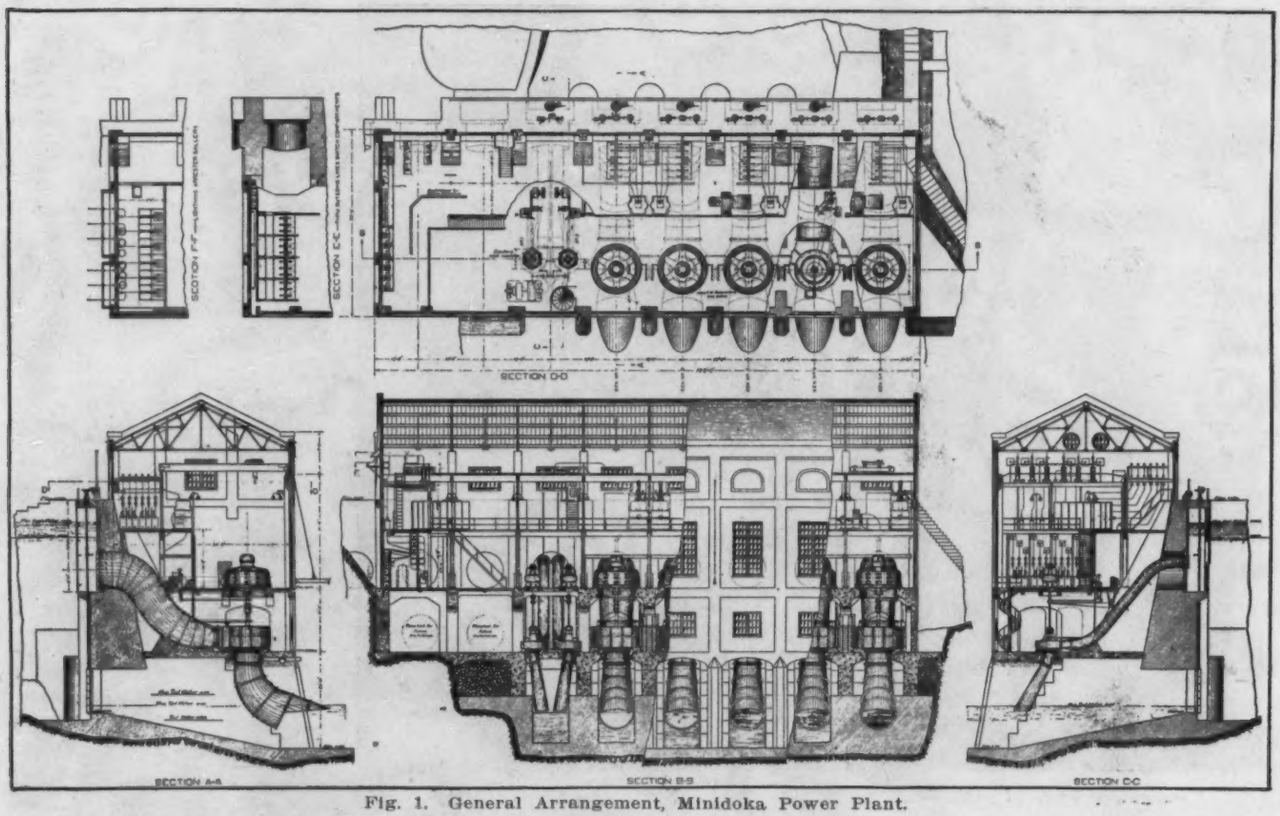


Fig. 1. General Arrangement, Minidoka Power Plant.

controlling feature. It might be mentioned that alfalfa is being grown in Southern California irrigated by water which is pumped from wells, and that orange groves are irrigated by water pumped in some cases as high as 200 ft., both with apparent financial success. On the other hand, to develop water for irrigation in the northern climes, where the season is short, and such crops as alfalfa, grain, potatoes, etc., must be depended upon, the maintenance cost per acre must be kept at a minimum.

Minidoka Project.

In the central southern part of Idaho, along the Snake River, The United States Reclamation Service has constructed what is known as the Minidoka project. This project comprises 130,000 acres of land, of which, roughly, 70,000 acres are fed by gravity system on the north side of the river, 10,000 acres by gravity on the south side of the river and the remaining 50,000 acres on the south side being supplied with water pumped from the south side gravity canal.

The Minidoka dam, designed primarily to divert water into the gravity canals, was constructed during the years 1904, 1905 and 1906. It is a rock-filled dam with concrete core, located neaer the foot of the rapids in the Snake River. It creates a fall which averages 46 ft. through the various stages of river discharge, and thus offers an excellent opportunity for development of power. In order that the water might be diverted from the main river channel during the construction of this dam, a deep sluicing channel was made through the lava formation on the north side of the river, and in this sluicing channel was constructed a concrete dam. This structure was built, so far as could then be foreseen, without complete power plant designs, so that it could later be used for he development of power. Through the base of this dam are five sluicing gates, and higher up are ten 10-ft. circular openings to be used for the power development.

In February, 1908, instructions were given to proceed with the design and construction of a plant at this point to supply power for pumping water to the high-land area 15 miles distant. This work was immediately undertaken and pushed with all possible speed. On the 8th day of May, 1909, one unit in the power plant and one unit in each of the three pumping stations were started and operated throughout the irrigation season.

The power plant equipment includes the following:

Five 1400-kilovolt-ampere, three-phase, 60-cycle, vertical alternators, each connected to a 2000-h.p. hydraulic turbine.

Two 120-kw., vertical exciter units, each direct connected to a 180-h.p. hydraulic turbine.

Five three-phase, air-blast transformers, delivering 33,000-volt current to the high-tension buses.

The general arrangement of the plant is shown in Fig. 1.

The transmission line, consisting of a single circuit of No. 3 and No. 5 B. & S. copper, carried on wooden poles, is 22 miles in length and crosses the Snake River in an 1150-ft. span of six-strand, 83,000-cir, mil copper cable at a point 11 miles below the power plant. A second similar line is being constructed on the south side of the river, using No. 5 wire, and the two lines will be connected as a loop system through the stations and to the towns on the project which are being supplied with light and power.

There are three pumping stations, each having a lift of 31 ft. (9.4 m.). No 1 contains 5 pumps, four of 125 second-feet capacity and one of 75 second-feet capacity; No. 2 four pumps, each of 125 second-feet capacity; and No. 3 three pumps, two of 125 second-feet and one of 75 second-feet capacity.

The problem in a system of this kind is to supply at as high an efficiency as practicable, taking into consideration operating conditions, first cost and maintenance, water in variable quantities with the least liability of shut-down and the least possible operating expense. Bearing this in mind, the choice of design of pumping station and especially the arrangement of the pumping units requires no small amount of study. The ordinary horizontal pump with the necessary foot valves would have made an expensive and awkward plant, and such an arrangement would have required a much larger amount of floor space than that occupied by the vertical units which were finally decided upon. The foot valves alone would have introduced a serious loss of head by offering considerable friction, and the control of the discharge of the water by means of gate valves would have involved an expensive installation and a constant source of annoyance in operation. The idea of controlling this pump by means of a cylinder gate, similar to those used in water turbines, resulting from a careful study of the problem, was carried out with very satisfactory results. By means of this gate the flow of water in the canals is under close control by the operator in the pumping station.

The pumps are installed in separate compartments and are direct connected to synchronous motors located directly above them and supported by a heavily reinforced concrete structure. As in the case of the generators at the power house, the weight of the rotating element is carried by thrust bearings located on top of the motors. In this case, however, the bearing is of the roller type, this style of bearing having been adopted on account of the necessity of reducing friction to a minimum in starting the synchronous motors.

Motor-operated steel plate sliding gates are used to admit water from the forebay to the pump pits, two gates being provided for each pit. Provision has been made for pumping out the pits in order that the synchronous motors may be started without load other than friction and windage of the rotating parts. For this purpose an auxiliary six-inch centrifugal pump was provided and arranged so that its suction could be connected to any pit and the water entirely removed before the motor is started.

When the plant was first designed, it was thought inadvisable to adopt an arrangement by which the pumping units could be started in quick succession, on account of the danger of the sudden rush of water down the canal injuring the banks. The auxiliary pump, therefore, is of only sufficient capacity to permit starting of pumps at intervals of 20 to 30 minutes. Two years' operation has shown this to be an unnecessary precaution, and by means of a specially designed starting valve each pump is now arranged so that it can empty its own pit while the motor is running on the compensator in starting. As soon as the pit is emptied the motor approaches synchronous speed and the field is excited. This arrangement has worked out very satisfactorily, and by its use a pump can be started up and put into full operation inside of two minutes.

Each pump has but one guide bearing, a long sleeve with a stuffing box at the top, and near the top of the sleeve the bearing is supplied with a semi-hard oil having the consistency of vaseline, forced in by a special motor-driven pump for each individual bearing. Lubricating in this manner forces the lubricant downward and excludes water from the bearing and any possible grit which may be in the water. In two years' time, no rust or wear is shown on these bearings, the shaft being as bright as when it came from the factory.

The upper end of the 5½-ft. concrete force mains leading from the pumps is closed by a check valve, to prevent water from running back to the pump in case of a shut-down. This valve is made up of ¼-in. boiler plate slightly bumped, hinged from the top of the head wall and seating against rubber packing set in a cast iron ring.

The motors for driving the 125-second-foot pumps are of the self-starting synchronous type, operating at 300 r.p.m. and receiving 60-cycle, three-phase current at 2,200 volts.

The motors for operating the smaller pumps are similar except that they have a capacity of 360 h.p.

The rotors are provided with squirrel-cage windings, to permit starting as induction motors, receiving for this purpose current at low voltage from compensators. The compensator voltage is so adjusted that the starting current drawn from the line does not exceed normal full load operating current of the motor, and by careful manipulation the motor can be brought into step with the line without exceeding this. It has been found that this can be most easily accomplished by exciting the fields while the motor is running at low voltage on the compensator and then throwing over to full voltage with the machine running steadily at synchronous speed.

The step-down transformers are of the three-phase, air-blast type, receiving 30,000-volt current through oil circuit breakers from the high-tension bus and delivering the 2,200-volt current through disconnecting switches and expulsion fuses to the low-tension bus.

In pumping station No. 2 are installed the transformers necessary for station No. 3. The distance between stations 1 and 2 is 1½ miles, and between stations 2 and 3 three-quarters of a mile, the highest voltage carried to the latter station being 2,200 volts.

The exciters and blowers for the transformers are driven by induction motors and a motor-driven air compressor has been provided for cleansing the apparatus in each station. Lightning protection is provided in the form of electrolytic arresters placed inside the building.

All the switching apparatus in the pumping stations is operated by distant mechanical control. A single high-tension bus has been provided, but provision has been made by means of disconnecting switches for receiving power from either or both transmission lines.

The power house and substation buildings up to

TABLE 1.

CONSTRUCTION COST OF MINIDOKA POWER AND PUMPING SYSTEM.

	Power plant	Pumping station No. 1	Pumping station No. 2	Pumping station No. 3	Transmission line	Total
Capacity	6,500 kw.	2,500 kw.	3,000 kw.	1,300 kw.	6,500 kw.	6,500 kw.
Building	$80,200	$34,500	$40,300	$19,200	—	$174,200
Machinery	167,600	78,800	73,600	32,500	—	352,500
Freight and hauling	25,100	11,800	10,600	6,100	—	53,600
Erection	62,300	18,200	16,800	8,600	—	105,900
Engineering and incidentals	13,600	5,600	5,300	2,800	—	27,300
Tail race	56,600	—	—	—	—	56,600
Pressure pipes	—	19,000	14,000	16,600	—	49,600
Double transmission line	—	—	—	—	35,000	35,000
Total	$405,400	$167,900	$160,600	$85,800	$35,000	$854,700
Unit cost	$63.00	$67.00	$53.00	$66.00	$5.40	$132.00

the motor and generator floor were built during the winter between the middle of November, 1908, and the first of February, 1909, and during this time the weather was very cold, reaching to as low as 15 deg. below zero. Considerable rock excavation was necessary at pumping station No. 2, and at the tail race for the power plant, and the concrete work on all of the structures had to be protected from freezing until set by means of artificial heat.

The apparatus, consisting of one unit in each station, was started in the spring of 1909 in temporary wooden structures covering the motor and generator floors; around these structures permanent buildings were finished during the summer. During the winter of 1909-1910 additional units were installed for the operating season. At the present time two additional units are being installed in the generating stations and two pumps in the pumping stations and during the winter of 1911 and 1912 three more pumps will be installed.

The following table of costs, when considered in connection with the strenuous conditions under which these plants were constructed, may be of interest. The figures given in the table do not include the cost of operators' quarters and road making. These items have been omitted, since they are so greatly dependent upon local conditions. The erection costs, however, include several items such as the cost of making preliminary tests of the hydraulic apparatus, the cost of temporary buildings for housing machinery during the time the permanent buildings were under construction and other items made necessary by the severe conditions under which the plants were constructed.

A large portion of the riveting of the turbine cases, penstocks and draft tubes was done in the field. In fact, the penstocks and draft tubes were completely assembled at the plant.

It may also be noted that the cost per kilowatt of station No. 2 is based on its transformer capacity of 3,000 kilowatts, while the unit cost at station No. 3 is based on its motor capacity.

In table II is shown the estimated operating cost, based on the actual cost of operation during the season of 1910, of that portion of the equipment then installed. There are two operators on each shift at the power house and there will be but one operator on each shift at each of the pumping stations. The cost of repairs during the season of 1910 was so ridiculously low that the figures given in the table are greatly in excess of the actual cost of repairs last year. This also applies to superintendence and general expense. Five per cent per annum depreciation has been allowed on the power installations, including buildings, and 10 per cent per annum on the transmission lines. No interest charge appears, since funds for the construction of all reclamation projects are, in reality, loaned by the United States to the settlers without interest.

The figures giving the acre-feet pumped by each station were arrived at by comparison of the installed capacity and the acre-feet pumped during the season of 1910, with the ultimate capacity of the various pumping stations and it was found that the figures thus obtained check very closely with the amount of water estimated to be necessary for the successful raising of crops on these lands; namely, three acre-feet per acre per season. The acre-feet pumped one foot high was found for each station by multiplying the total acre-feet for that station by the approximate net lift, name-

TABLE III.

FULL LOAD EFFICIENCIES.

	Efficiency	Net efficiency from water behind the dam
Turbines	81.5 per cent	81.5 per cent
Generators	96.0 "	78.2 "
Step-up transformers	98.4 "	77.0 "
Transmission line	90.0 "	69.3 "
Step-down transformer	98.0 "	67.9 "
Motors	94.0 "	63.8 "
Pumps	72.5 "	46.3 "

TABLE II

ESTIMATED MONTHLY OPERATING COSTS OF MINIDOKA PUMPING SYSTEM BASED ON ACTUAL COST DURING SEASON OF 1910 EXCLUSIVE OF DITCH TENDING.

	Power plant	Pumping station No. 1	Pumping station No. 2	Pumping station No. 3	Transmission line	Total
Capacity	6,500 kw.	575 sec. ft.	500 sec. ft.	325 sec. ft.	6,500 kw.	—
Labor	$700	$300	$300	$300	$100	$1,700
Supplies	150	30	30	15	5	230
Repairs	75	20	20	10	10	135
Superintendence and general expense	400	200	200	150	40	990
Depreciation	1,460	670	670	350	300	3,450
Total	$2,785	$1,220	$1,220	$825	$455	$6,505
Acre feet pumped	—	25,000	20,000	15,000	—	—
Acre feet pumped 1 ft. high	—	750,000	600,000	450,000	—	1,800,000
Kw-hr	3,600,000	1,500,000	1,200,000	900,000	—	3,600,000
Cost per acre ft. 1 ft. high	0.154 ct.	0.163 ct.	0.203 ct.	0.183 ct.	—	0.362 ct.
Cost per kw-hr	0.077 ct.	—	—	—	—	0.18 ct.
Cost per acre per season	—	—	—	—	—	78 ct.

Depreciation at 5 per cent per annum on complete power installation, 10 per cent on line.

Estimates for the six months of the irrigating season assuming that the winter operating expenses are covered by the sale of power.

Allows three acre-feet per acre during season over 50,000 acres.

Average lift 73 feet.

!y, 30 ft. The results of last season's run showed that the kilowatt-hours generated at the power plant were almost exactly double the acre-feet pumped one foot high by the pumping stations; and since one kilowatt-hour is equal to 1.01 acre-feet one foot high, this would indicate a working efficiency from power plant to water delivered in the upper canals of approximately 50 per cent. This actual working efficiency should be compared with the following table of full load efficiencies, starting with the water behind the dam and working through the system to the water delivered in the upper canals. The cost of operation per acre-foot pumped one foot high given for the various pumping stations might be taken to represent what a company would expect to pay for operating expenses, exclusive of the cost of power in a pumping station of this character.

In the table of operating cost it has been estimated that the entire winter operating expenses, including fixed charges, will be covered by the sale of power and that the land under the pumping season will not be charged with any standby expenses for the winter season. In such a system as this, where a large amount of power is required during the summer irrigating season, and none during the winter season, the development of a winter load is very desirable, and with this in view, the transmission lines have been extended to the towns of the Minidoka Project and power is these sold for commercial purposes. Extremely low rates are offered for electric heating and the use of large amounts of power for all purposes during the winter is encouraged in every possible way. By furnishing power at very low rates, especially during the winter months, the annual operating and maintenance charges against the pumping system are reduced and the settlers on the project, who have paid for this work, have the benefit of cheap light, power and electric heat.

THE VOLTAGE REGULATOR AT NORTH TOWER.

BY GEO. H. BRAGG.[1]

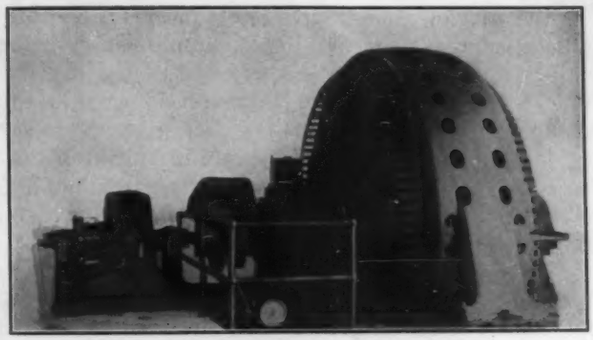
In every system of electrical distribution there is a loss of energy and consequently a loss of voltage. The voltage delivered by the power house to the lines decreases in value as the distance becomes greater, depending in amount upon the size of conductors and load.

The commercial effect of this voltage loss is "poor light," or inoperative induction apparatus, and unless some means is employed to overcome it, the quality of the service is "poor."

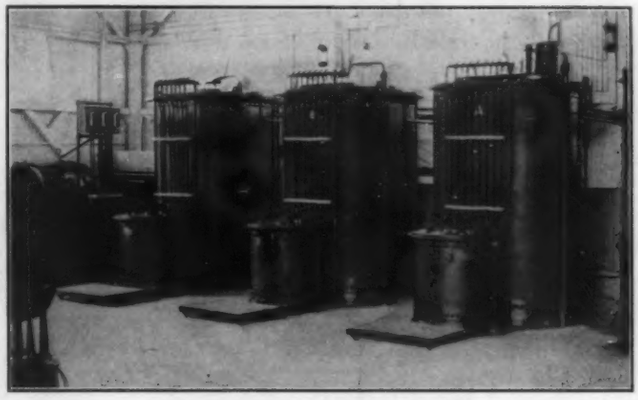
Four types of voltage regulators or compensators are on the market today, each adapted to a particular kind of work. Without going into a description of them, they are as follows: The induction type, the step-by-step or dial switch type, the relay type, and the synchronous type.

The first and second are used principally on the substation feeders, the third at the power house on the generators, although they are sometimes used in the substation on synchronous apparatus, and the fourth on long-distance transmission systems.

[1]Operation and Maintenance Department, Pacific Gas and Electric Company.



Synchronous Regulator.



Motor-Generator Exciter Set.

Main Transformers.

The regulator at North Tower is of the latter type. In every respect it is like the revolving-field generators at the power houses. Its nameplate reads as follows: "S. K. C. System. Revolving Field Alternator. Serial No. 1235—Type 144—4400 K. W. Three-phase, 60-cycle, 11,000 volts, speed 300 r.p.m."

A brief description of the auxiliary apparatus comprising the complete installation will serve to explain the illustrations and at the same time assist in a better understanding of the operation of the regulators. The 110-kw. motor-generator set serves the double purpose of exciting the regulator and furnishing power to its starting motor. It is driven by a 2200-volt motor supplied by a bank of 35-kw. transformers, which steps down the station voltage from 11,000 to 2200 for the motor. The 100-h.p. direct-current starting motor is geared to the shaft of the regulator, and it receives its power from the motor-generator set, as above stated.

In order to place the regulator in operation on the transmission system the 100-h.p. motor is furnished with power, and gradually the speed of the regulator is increased from rest up to 300 revolutions per minute. At the proper instant the main switch is closed and the regulator then continues to operate in synchronism at the constant speed of 300 revolutions per minute, receiving the power to drive it from the lines. There is no further use of the starting motor; therefore, it is disconnected from the regulator and shut down.

It may be of interest to describe here the mechanical connection between the starting motor and the regulator. Bolted to the shaft of the regulator there is a large gear which meshes with a pinion on the shaft of the starting motor. This pinion is capable of being moved parallel with the axis of the starting motor shaft, the key and shaft being approximately double the width of the pinion. When the motor has performed its work, a lever is thrown over, and the pinion is moved on its shaft until it is out of mesh, then by opening the switch the starting motor will come to rest. The regulator is now capable of regulating the line voltage; by turning the hand wheel on the rheostat in its field, the current in its armature will vary. A point can be found where the current will be at a minimum, and a turn of the hand wheel in either direction will cause the current to increase. Graphically this is shown in Fig. 1.

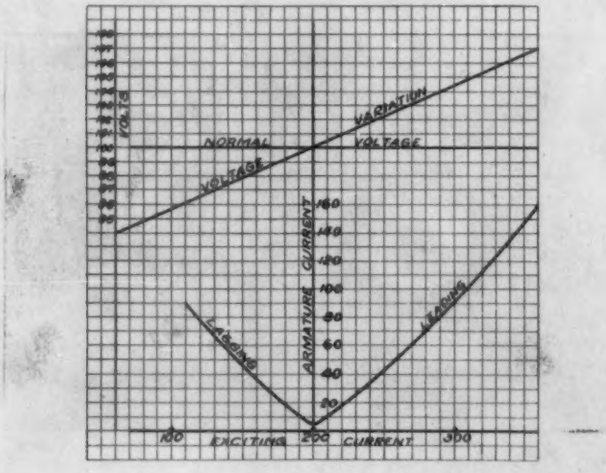


Fig. 1.

Increasing the exciting current from the minimum armature current condition causes the regulator to draw a leading current, which in turn causes the voltage to raise. Likewise, decreasing the exciting current from the minimum armature, current condition causes the regulator to draw a lagging current, and this current causes the voltage to lower. The straight line at the top gives an idea of about the range of the regulator. It shows a regulation of approximately ten per cent, and for all variations within this range the line voltage can be held constant. To make the regulation automatic the rheostat of the regulator is equipped with a motor as shown in Fig. 2.

The motor is operated by a relay switch which in turn is operated by a contact making voltmeter. The wiring of this apparatus is shown in Fig. 3.

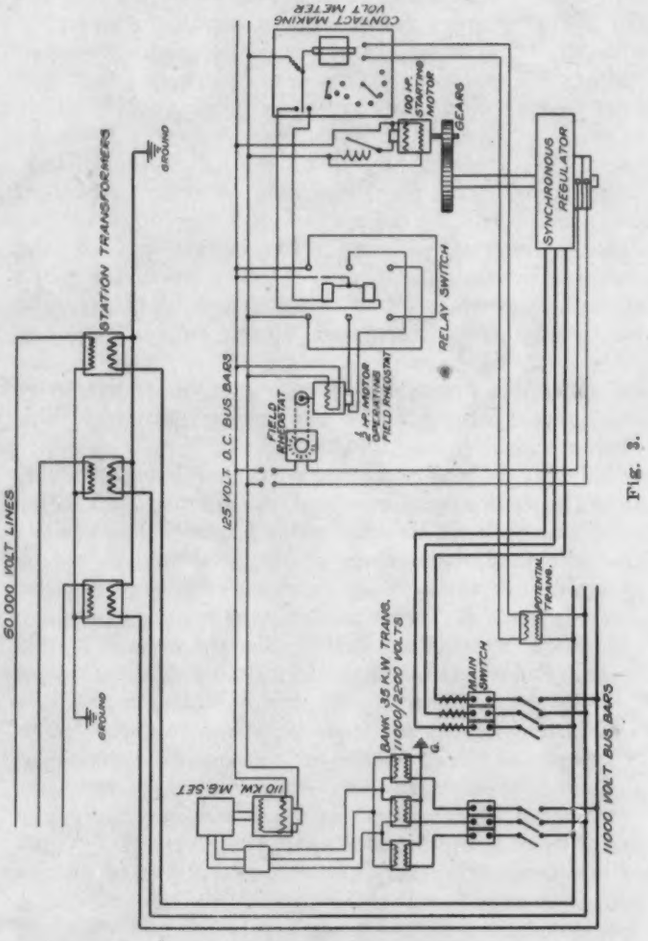


Fig. 3.

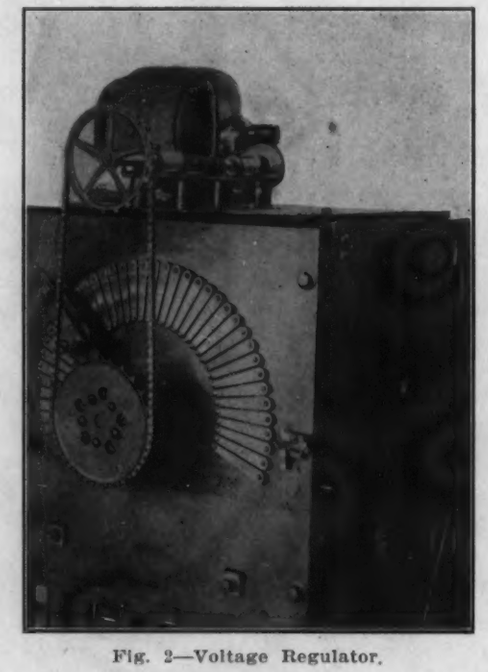


Fig. 2—Voltage Regulator.

A change in the line voltage from the predetermined value causes the contact making relay to move up or down. This movement operates the relay switch, which in turn operates the motor on the rheostat.

ENTROPY.

BY ALEXANDER MCADIE.

Many of us read with interest the discussion on "The Physical Meaning of Entropy," in the Journal of Electricity, Power and Gas, Dec. 3, 1910, and succeeding issues. Mr. A. L. Menzin's papers brought home to most of us the fact that aside from the mathematical concept of entropy as set forth in the Clausius integral $\int \frac{dQ}{T}$ there was and should be a physical significance which treatises in thermodynamics fail to convey to students.

The discussion between Mr. Menzin and Professor Durand was in my opinion one of the most valuable and enlightening contributions to the subject that has yet appeared and should be given wide publicity. Students of thermodynamics, especially young men in the universities, will do well to obtain copies of the Journal of the dates mentioned for future reference.

Waste of heat accompanies every practical attempt to obtain work from heat. To the engineer it is all important to have clear conceptions of heat, energy, waste of heat and the process and agency through which transformation into motive power is accomplished.

Mr. Menzin defines entropy as a property of matter which determines the least amount of heat which must be rejected to an external substance during any change of thermal state. It is then the least amount of heat which must be rejected for each and every degree of the absolute temperature at rejection. Professor Durand while not questioning the method employed by Mr. Menzin, whereby the rejection of heat or the change of entropy backward is made to equal the change forward, insists that this does not aid in getting a clear idea of the change of entropy for a simple heating and cooling process. He holds that it would be well if all engineers would realize once and for all

> "That from the nature of things such attempts (to give a physical conception to entropy) must be futile and such effort will only result in a labored and backhanded physical concept which will be of small value either to physicists or engineers."

The writer is not an engineer; but only a meteorologist who while looking at the clouds from day to day, cannot fail to wonder at the processes at work in the expansion and condensation of the water vapor. He wishes he were an engineer, for to him the clouds represent thermal engines and he longs for the time when they will be so studied and classified rather than as now, according to appearances. In considering warm and cold cloud masses rising and falling and going throught various cycles, entropy will be a factor of importance. It is therefore necessary at the outset to have a clear conception of the term "entropy" not merely as a mathematical abstraction but as a physical condition of heat transfer.

There has just come into his hands an address delivered to the Physical Society of London, Feb. 10, 1911, by Professor H. L. Callendar, which contains a discussion of the caloric theory of heat as developed by Carnot in his famous essay on the motive power of heat (Paris, 1824). From it the writer gains a clearer conception of entropy and desires to give others the same opportunity. Few men are better qualified than Professor Callendar who has spent many years in both experimenting and teaching. The relations between energy and heat, especially in reversible processes, are more clearly expressed, Callender thinks, by the use of Carnot's conception of caloric than by the present kinetic theory. "It emphasizes the differences," he says, "between reversible and irreversible transformations and directly provides the natural measure of a quantity of heat as distinct from a quantity of thermal energy."

In the Carnot equation $W/G = F(t)$ or $dw/dt = QF'(t)$ the Carnot function $F'(t)$ must be the same for all substances and hence the efficiency is independent of the agency used; but is a function of the temperature limits only. In a gas expanding from V_o to V,

$$Q = R \log_e \left(\frac{V}{V_o}\right) F^1 t$$

and the difference of the specific heats at constant pressure and volume given by $S_p - S_v = \frac{R}{T F(t)}$ is independent of the pressure and is the same for all equal volumes of all gases. Thus heat is measured as caloric and temperature is measured on the scale of a gas obeying the law $pv = RT$ and S_v independent of pressure. If W be the work produced from a quantity of caloric Q at temperature T then $W = AQ(T - T_o)$ which is the correct, final solution of the problem.

According to Carnot's theory it can be assumed that the motive power of the caloric generated at any temperature, namely, AQT, should be equal to the motive power consumed in friction. The absolute unit of caloric, which may be appropriately called the Carnot, is that quantity which is capable of doing one joule of work per degree fall. The mechanical equivalent of Q Carnots at T Absolute is QT joules.

From Carnot's data the work done in a cycle per gram of steam vaporized at 100 degrees C. per degree fall, is 0.611 kilogrammeters, or nearly 6 joules. The caloric of vaporization is 6 Carnots. Similiarly from Kelvin's data for the pressure required to lower the freezing point 1 degree C. the caloric of fusion of ice is 1.2 Carnots.

Callendar refers to a proposed experiment where steam at 100 degrees C. is condensed on one side of a conducting partition, while ice is melted at 0 degrees C. on the other. The caloric falls irreversibly by conduction. For each gram of steam condensed or for each 6 Carnots supplied at 100 degrees C., 540/79.5 grams of ice would be melted. Six Carnots at 100 degrees C. allowed to fall directly to 0 degrees C. by conduction produce $\frac{540 \times 1.2}{79.5}$ or 8.17 Carnots at 0 degrees C. The quantity of caloric at 0 degrees C. is greater than that supplied at 100 degrees C. in the proportion of 8.17 to 6, which is nearly the same as the ratio 373/273 of the absolute temperatures. The motive power of the caloric at 100 degrees C. or $6 \times 373 = 2{,}238$ joules is the same as the motive power of the caloric found at 0 degrees C., namely, $8.17 \times 273, = 2{,}231$ joules. Professor Callendar points out that since a quantity

of heat is most directly measured as a quantity of thermal energy, we have unconsciously gotten the idea that heat is energy and that a quantity of heat is completely specified by its energy equivalent.

He says,

"The absurdity would be at once apparent, to take an analogous case, if we were to measure a quantity of electricity always in kilowatt-hours. The equivalent energy determines the cost of production and is for many purposes the appropriate and sufficient measure, but we should fare very badly in electrical theory without the separate units of quantity in ampere-hours and pressure in volts."

Caloric then is the "thermodynamic function" of Rankine and the "equivalence value of a transformation" of Clausius, who in 1865 finally gave it the name entropy and defined it as the integral of dQ/T, or as Callendar points out, much better defined as A in the equation $W = AQ(T-T_0)$.

Callendar concludes with the statement that the conduction of caloric is closely associated with the electrons and that the science of heat would gain by attaching a more material conception to the true measure of a quantity of heat as distinguished from a quantity of thermal energy.

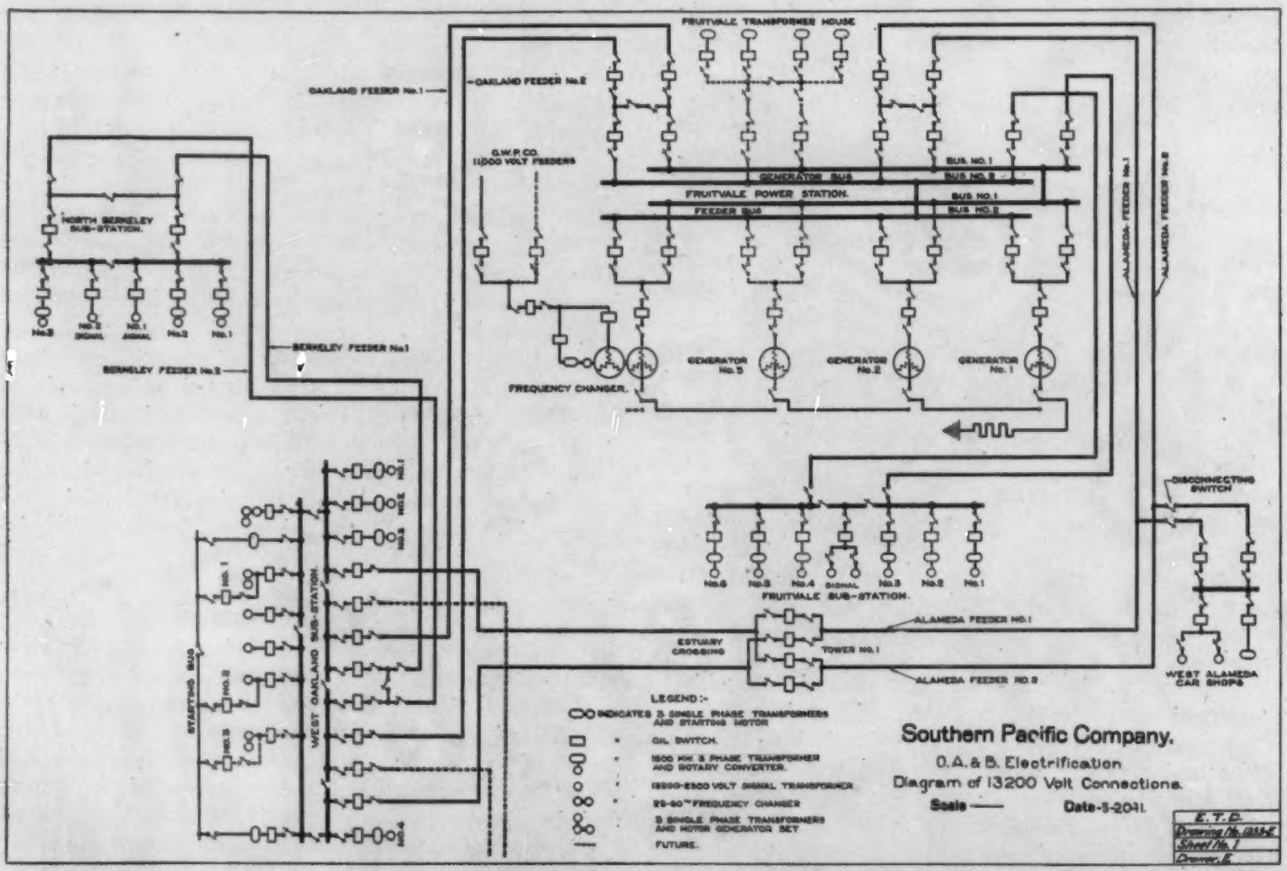
In conclusion the writer wishes to urge the general adoption of the absolute scale of temperature, whether based on the absolute zero of the gas thermometer or the absolute zero of heat according to Kelvin. He believes that the use of this scale and the disuse of both Fahrenheit and centigrade scales will assist greatly in the forming of clearer conceptions of heat quantities and processes. While urging engineers to use the one proper temperature scale, he is not unaware of the fact that it is also incumbent upon meteorologists and physicists to set the example by using proper scales and units. In this connection he refers to a paper upon "New Units in Aero-Physics" published in the American Journal of Science, October, 1910.

WHERE LIGHTNING STRIKES.

It is shown that 362 out of each million buildings in Schleswig-Holstein, which has an area of about 7,200 square miles, are annually struck by lightning. The number of buildings struck in the open country is nearly double that struck in the towns. The strokes were much more frequent and the damage was two and one-half times as great with buildings with thatched or wooden roofs as with slate or metal roofs. The greatest damage occurred on the average during the last third of July, the greatest number of electric storms occurring during that period. The greatest number of electric discharges was observed between 4 and 5 o'clock in the afternoon.

All kinds of trees were struck, but certain kinds more frequently than others, depending upon the character of the bark and wood, which in some cases furnish a poorer conductor and thus afford greater protection than others. Poplars were most frequently struck. Of 239 trees struck in 15 years, 109 were poplars, 26 oaks, 3 linden, 21 ash, 11 fruit, 10 willow, 10 pine, 6 alder, 3 elm, 1 birch, and 1 beech.

It was observed that strokes were two and one-half times more frequent in marshy than in dry sections, and that the frequency of strokes decreased with forest growth and increased with its removal.



Wiring Diagram Alameda County Electrification to Accompany Article on Fruitvale Power House, this Journal, June 3, 1911.

THE NEW YORK-DENVER TELEPHONE CIRCUIT.[1]

BY B. GHERARDI.

The New York-Denver circuit has a length of a little over 2,000 miles, that is, it is more than twice as long as the New York-Chicago circuits, which are about 950 miles long, and is a little less than twice as long as the New York-St. Louis circuits, which are about 1,050 miles long. Until the completion of the developments which have made the New York-Denver circuit possible, the New York-Chicago and New York-St. Louis circuits represented practically the limits of long distance transmission. Now service from New York to Denver can be given which is as good as, or even better than, the service given a year or two ago from New York to St. Louis or Chicago, and this without using any heavier wire than was formerly employed. All our old circuits from New York to Chicago and St. Louis were No. 8 B. W. G. wire, weighing 435 pounds to the mile. No heavier wire is used to get the New York-Denver service.

One of the aims of Mr. Vail is to give universal service. The first step in the direction of giving such service is obviously to be able to give transcontinental

Diagram 1.

service—that is, a talk from New York to San Francisco. Diagram 1 will show how much of a step in this direction has been made since Mr. Vail's wish on this matter was stated about two years ago. This diagram shows what we could do two years ago, what we can do now, and how much remains to be done to get to San Francisco. It was a long step from Chicago to Denver. One more step a little longer will take us to San Francisco.

Two years ago we did not know how to successfully load No. 8 circuits; how to commercially phantom No. 8 circuits, or how to combine phantoming and loading. Since that time we have found out how to do all of these things, and it is as a result of these developments that the Denver circuit is a reality today.

Before explaining how each one of these results was accomplished, and the part which each result contributed to the achievement of talking from New York to Denver, I will describe the circuit. Diagram 2 shows in a general way the New York-Denver circuit. From New York to Morrell Park (the test station just outside of Chicago), there are two loaded No. 8 circuits. These are phantomed, thus creating a third circuit and this phantom is also loaded. From Morrell Park to Omaha there is a loaded No. 8 circuit. No loaded phantom has as yet been provided here because the pole line did not carry two No. 8 circuits so located with relation to each other that they could be phantomed. Arrangements are being made to move a No. 8 circuit on this line to pins adjacent to the present loaded No. 8 circuit and as soon as this is done a phantom will be created from the two circuits and this phantom will also be loaded, thus giving between Chicago and Omaha the same arrangement as now already exists between New York and Chicago. From Omaha to Denver there are two No. 8 circuits which have been phantomed, thus creating a third circuit, and the two physical circuits and the phantomed circuit are all loaded, thus giving from Omaha to Denver the same general circuit equipment as now exists between New York and Morrell Park.

The circuit from New York to Denver, utilizing the phantoms where they exist and including the reflection losses due to the present irregular arrangement, is equivalent in transmission efficiency to about 30 miles of standard cable. The circuit if connected throughout on a non-phantomed physical circuit over the same route is equivalent to about 32 miles of

GENERAL ARRANGEMENT OF NEW YORK-DENVER CIRCUIT

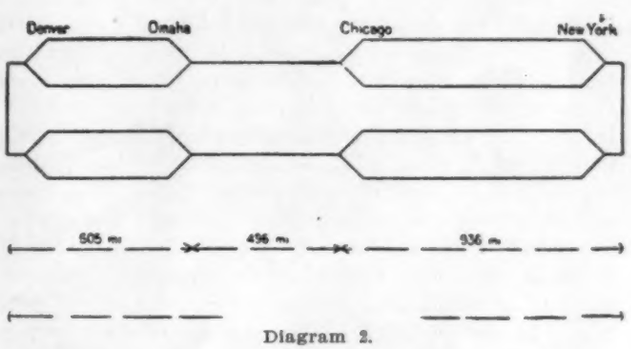


Diagram 2.

standard cable. When the final arrangement is completed btween Chicago and Omaha our present estimate is that a New York-Denver connection on the phantom will be equivalent to between 28 and 29 miles of standard cable. If the circuit were made up throughout of unloaded No. 8's it would be equivalent to 69 miles of standard cable. A No. 8 unloaded circuit from New York to Chicago by the shortest route is equivalent to about 34 miles of standard cable from test board to test board. It will thus be seen that the new circuits to Denver are better than our old circuits were to Chicago. Not only are they better, but they are cheaper because with the art as it was two years ago with four No. 8 wires we could get two circuits; now with four No. 8 wires and some coils and insulators we get three circuits of more than double the transmission efficiency. It is interesting to consider what results these cheaper circuits will accomplish when used in connection with the Chicago business. The No. 8 unloaded circuit to Chicago has a transmission efficiency of 34 miles. By the use of telephone relays or repeaters this can be cut down to about 22 or 24 miles. The efficiency of the No. 8

[1]Abstract of paper read before New York Telephone Society.

loaded circuits from New York to Chicago is equivalent to about 17 miles of standard cable. The efficiency of the loaded phantom is equivalent to about 15 miles of standard cable. As soon as certain additional circuits via Pittsburg are loaded and phantomed, we shall start using the high-grade circuits for New York-Chicago business.

As I have already stated, there are embodied in the New York-Denver circuit three advances recently made in the art, namely

Loading No. 8 circuits.

Phantoming No. 8 circuits, and combining loading and phantoming on the same circuits.

The problem of loading No. 8 circuits was primarily a problem in connection with the insulation of the line wires. A No. 8 circuit can be loaded with the same coils used on No. 12 circuits and these coils would be spaced in the same manner, that is, at 8-mile intervals. It has been a fact known to us ever since we started to do commercial loading that low insulation on a loaded circuit has a much greater effect in impairing the efficiency of such a circuit than the same insulation has on an unloaded circuit. It has also been known that the effect of low insulation on the No. 8 circuits was much more serious than on the No. 12 circuits.

When we first began to load our open wire circuits about ten years ago it was found that the No. 12 gauge circuits which had been loaded gave satisfactory results in dry weather. In wet weather the results were not so good, due to the lower insulation at such times, but these results were good enough. In the case of No. 8 circuits, however, it was found that when they were loaded the effect of low insulation was so serious in wet weather that at such times the circuit was no better than if it was unloaded—sometimes even worse. A system of loaded No. 8 circuits could not, therefore, be considered satisfactory, as it would be a system which part of the time would be better than if not loaded and part of the time worse.

It having been established that a substantial improvement would have to be made in the insulation of No. 8 circuits in order that they might be successfully loaded, and reasonably uniform results obtained from the loading, a study of line insulation conditions was made to determine what steps would be necessary in order to improve the line insulation. Aside from the general insulator leakage two particularly weak points were found in the insulation of open wire circuits. One of these was at transposition points. Diagram 3 shows the arangement of the wires on a standard single pin transposition. It will be seen that with this arrangement there is a very direct leakage path from one wire to the other during wet weather. The part of the insulator surface protected by the petticoat is the only part that is of much value during wet weather. Actual measurements showed that the leakage on lines equipped with standard single pin type transposition insulators was 20 per cent greater during wet weather than on lines where the two wires were never allowed to be on the same pin. Of course the old standard transposition which employed two insulators, both of the transposition type, and in which the wires were tied to both of them, was just twice as bad as the single pin transposition already discussed. The method of overcoming this difficulty was to transpose the wires without bringing them onto the same insulator. This is accomplished in the manner shown in the second part of Diagrom 3, that is, to employ the phantom transposition bracket for transposing a physical circuit. The same problem, of course, arises when phantoms are involved and having used the phantom bracket for the transportation of physical circuits, something else is required when phantoms are involved. This arrangement is also

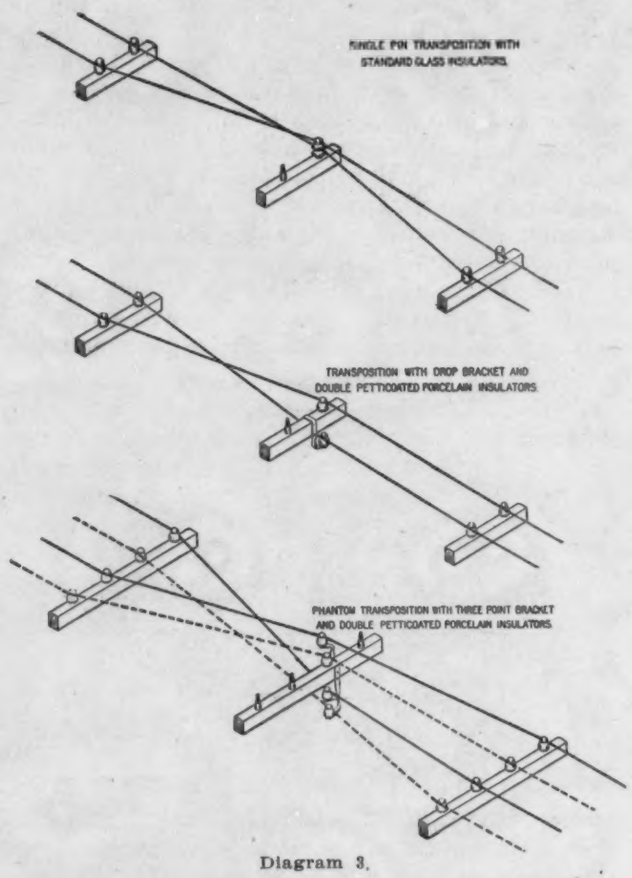

SINGLE PIN TRANSPOSITION WITH STANDARD GLASS INSULATORS
TRANSPOSITION WITH DROP BRACKET AND DOUBLE PETTICOATED PORCELAIN INSULATORS
PHANTOM TRANSPOSITION WITH THREE POINT BRACKET AND DOUBLE PETTICOATED PORCELAIN INSULATORS

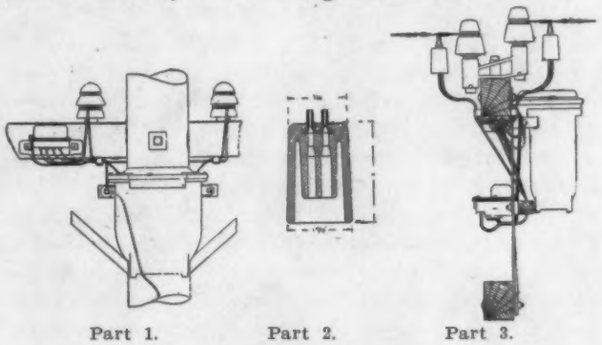
Diagram 3.

shown in the diagram. By the means described above the transposition as a factor in producing low insulation is eliminated and the transposition points are made just as good as any other point in the line.

Another point at which it was found that there was considerable leakage was where, for the purpose of inserting loading coils, connecting with a test station, or for any other reason, the wires were bridled. These places were particularly bad during wet weather, especially after the bridle wire had been in service for a short time and had weathered. The path of this leakage is shown in part 1 of Diagram 4. The braid on the bridle wire soon becomes weathered and when wet is a fair conductor. Leakage takes place easily over the wet surface at the end of the rubber insulation and thence to the wet braid. This difficulty was overcome by a very neat device known as a bridle wire insulator. Part 2 of the diagram shows a picture of such a bridle wire insulator, and part 3 shows a cross section of it. The two wires shown

in connection with this bridle wire insulator extend—one to the loading coil and the other to the lightning arrester. The adoption of this arrangement has completely eliminated low insulation at bridling points.

In addition to the changes at transposition points and at bridling points referred to above, it was thought desirable on the first of these loaded No. 8 circuits to use a line insulator that would be more efficient than our standard glass insulator. After a careful study of insulator design and insulator materials, it was decided to try on these circuits a double petticoated porcelain insulator. Tests on these insulators extending over a period of several years have shown that the new insulator is several times as good in wet weather as the standard insulator. Part of this improvement is due to the design of the insulator. Some is attributed to the use of porcelain. An objection to these insulators is that they are not so easy to manufacture uniformly, and that each insulator must be inspected, whereas with glass insulators they may be inspected by sample. These porcelain insulators also cost considerably more than glass insulators.



Part 1. Part 2. Part 3.

Diagram 4.

As a result of applying the improvements described above to our No. 8 circuits, it has been found by measurements and tests extending over a long period that the line insulation was at all times sufficiently good to warrant the loading of No. 8 circuits.

Phantoming No. 8 Circuits.

The problem of the phantoming of No. 8 circuits is one in phantom repeating coil design. To meet the special conditions existing in connection with the phantoming of loaded No. 8 circuits as used in our plant, it was desirable that apparatus should be developed of the highest possible transmission efficiency. In order to do this the ringing efficiency of the phantom coil was sacrificed and special means for ringing through these coils had to be adopted. In this way and by specially designing a coil to meet the circumstances of these circuits, coils that were suitable were developed. The manner in which these coils are used in phantoming a circuit is shown in Diagram 5.

Up to very recently, while we knew how to phantom ordinary circuits, it was impracticable to phantom loaded circuits because the loading coils so unbalanced the phantom and so increased its effective resistance that a phantom circuit created out of loaded circuits could neither be made quiet nor made efficient from a transmission standpoint. This problem is one of loading coil design. Such coils were devised and are now in successful use on the New York-Denver circuit.

The phantom produced in this manner is, however, not loaded. It is, of course, desirable to load the phantom in order to obtain the benefits of improved transmission on this circuit also. To do this another coil was devised, the windings of which were so arranged that they would introduce inductance in the phantom circuit without affecting the side circuits.

An important piece of work which it was necessary to carry on in parallel with the work dealing with the wire plant, was the development on a satisfactory cord circuit to be used with these very efficient loaded lines. Very successful results have been obtained in this direction, and a cord circuit has been devised on which the transmission losses are almost negligible. With the new cord circuits the loss brought in on the New York-Denver circuit by the two terminal cords at the toll switchboards at New York and Denver and the two intermediate cords at Morrell Park and Omaha

USE OF PHANTOM REPEATING COILS

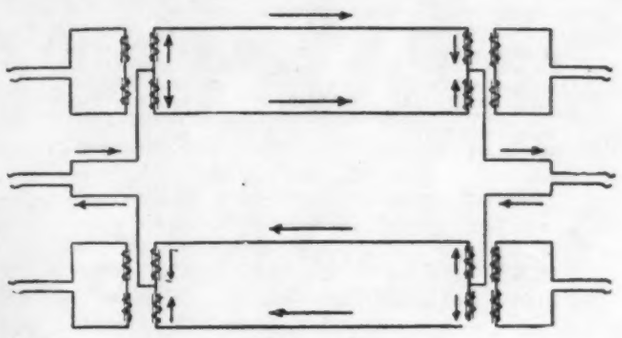


Diagram 5.

is only 0.3 miles of cable. With the old type of cord circuit these losses were substantially greater. The losses with the old cord circuits were equivalent to making the line from New York to Denver 300 miles longer than with the present arrangement.

While the foregoing touches upon the engineering work necessary to successfully construct a circuit which would operate from New York to Denver, another series of problems arose from the fact that we have not now and could not for many years expect to have traffic sufficient to justify three or even one through circuit from New York to Denver. Plans were worked out by which at certain points one or both of the physical circuits could be cut and made available for way connections without interfering with the use of the phantom on a through connection. Such arrangements are used at several points along the circuit. At other points the physical circuits, and also the phantom, are terminated and are available for connection to any other circuits in the usual manner.

Each of the various functions which we have caused these four wires to perform by the arrangements described above have been obtained in such a manner that no one of them substantially interferes with the others. The maintenance, however, of the circuits—particularly of the phantom—is not an easy proposition, and requires considerable skill on the part of those responsible for it.

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Electrical Accidents

Garbled press accounts of several distressing electrical accidents are causing much unjust criticism of the power companies. Electricity is mysterious enough without ascribing to it properties which exist only in the disordered brain of a reporter inexcusably ignorant of the fundamental characteristics of commercial electrical phenomena. Whether governed by accident or by intention, an electric current obeys fixed mathematical laws whose conditions are followed in the design of electrical systems built for maximum efficiency, which means the least possibility of disaster.

Every man who has any business around a power system or where he can touch live wires knows, or ought to know, that if he places his body either directly or in metallic connection between two points where there is a difference of potential, a current will flow between these points. According to Ohm's law if the difference of potential is sufficient and the resistance of the body (which varies somewhat, depending upon the length of the path traversed and the nature and condition of the contacts) low enough to allow about one-half an ampere to pass through a vital part, the result will generally be fatal. If the current flow is the result of an extreme potential difference, such as a direct ground connection from a 60,000-volt circuit, a much larger current than that which is necessarily fatal may flow and it is those currents of high density which cause the severe burns often accompanying these accidents. Many freak accidents are recorded where the victim has been fearfully burned and yet has survived. These are in no way due to electrical peculiarities, but to the means of contact or other extraneous conditions. For instance, examples have been known where the victim, while perspiring freely, has formed a conductor for a short-circuit in which the entire current passed over the body surface, which offered a much lower resistance to the passage of the current than the skin at the points of contact.

To so cover all live circuits that human contact could not be made, even if intentionally attempted, would be impracticable, and to provide for all unforeseen accidents would be impossible. As a matter of record, accidents of this sort have invariably occurred through events so unusual or unforeseen, that blame could not be attached to the operating company and in most cases the probability of repetition would be most remote. On the other hand the contributory cause is generally carelessness or thoughtlessness on the part of the victim.

It is slight satisfaction to one who may survive or to the loved ones who may be left behind, that a momentary abberation of attention has earned such a punishment. These attributes are a manifestation of the undeveloped part of human nature. Here then is where the improvement must be made. We have learned not to place our head in a furnace to observe the fire or to stand on the track before an approaching train, and we must remember that, live or dead, electrical circuits appear the same, it is foolhardy to take any chance; if the body by contact forms a path of least resistance between points having potential difference a current will flow.

PERSONALS.

A. H. Woodbine, an engineer of Los Angeles, is at San Francisco.

C. N. Black, general manager of the United Railroads of San Francisco, is visiting New York and other Eastern cities.

H. A. Lardner, manager of J. G. White & Co.'s Pacific Coast branch office, is making a trip to the firm's New York office.

S. L. Stovall, assistant to John Coffee Hays, general manager of the Mt. Whitney Power Company of Visalia, is at San Francisco.

J. P. Poindexter, manager of the Pacific Gas & Electric Company's system at Marysville, was at San Francisco during the past week.

J. G. Anderton, manager of the Sierra & San Francisco Power Company's Tuolumne division, has returned to Sonora from San Francisco.

Wynn Meredith, manager of Sanderson & Porter's Pacific Coast branch, has just returned to his San Francisco office from British Columbia.

E. V. D. Johnson, general manager of the Northern California Power Company, with headquarters at Redding, was at San Francisco this week.

C. E. Grosbeck, one of the vice-presidents of H. M. Byllesby & Co., who recently returned from a trip to the Hawaiian Islands, is at Portland, Ore.

T. E. Bibbins, assistant manager of the General Electric Company's San Francisco office, has returned to San Francisco after visiting the factory at Schenectady, N. Y.

W. L. W. Curl, the California State Secretary of the National Association of Stationarry Engineers, attended the convention of the organization at San Francisco during the past week.

L. H. Baldwin, with the Pacific Coast branch office of the Kellogg Switchboard & Supply Company, has returned to San Francisco, after a trip through Northern California and Southern Oregon.

J. W. White of the San Francisco office of the Fort Wayne Electric Works, is making an extensive tour of the Nevada and Northern California mining camps, in the interests of electric rock drills and other apparatus.

F. F. Barbour assistant to the president of the Pacific Gas & Electric Company, has just returned to San Francisco from an extended tour of Central and Northern California, where the corporation has numerous electric power plants.

Thomas Mirk, of Hunt, Mirk & Co., spent the past week at San Diego, in connection with the work of remodeling and increasing the capacity of the San Diego Electric Railway Company's power plant, which is progressing rapidly.

Harry Leavitt, a popular engineer, who was for a number of years on Atlantic steamers and more recently in charge of power plants in the Fairmont Hotel and elsewhere, has succeeded Chief Engineer Richards in the Monadnock Building, San Francisco.

F. C. Barrington has resigned as president and manager of the Columbian Electric Company of St. Joseph, Missouri, to become manager of the lighting department of the St. Joseph Railway, Light & Power Company. His holdings have been taken over by W. R. Thomas, his business partner.

John R. Freeman, a consulting engineer of New York, is on his way to San Francisco to assist in tabulating the data on the value of the Spring Valley Water Company's properties for the Board of Public Works. The company's latest selling price is said to be about $41,000,000.

N. A. S. E. CONVENTION.

The eighth annual California State convention of the National Association of Stationary Engineers opened at San Francisco Tuesday June 6th. Forty-four delegates had been elected and there was thus a full representation of the 900 engineers composing the six associations in the State of California.

The following resolution was adopted at the opening on June 6th: "Resolved, that the eighth annual California State Association in convention assembled, that members of this association shall remain absolutely neutral in any controversy between employers of engineers and engineers themselves."

On Tuesday night a theatre party at the Orpheum was attended by a large party of delegates and their ladies.

On Wednesday a business session was held at the Merchants' Exchange building at 3 p. m. A sight-seeing automobile ride was given to the ladies at 10 a. m. and luncheon at Union Square Hotel upon return.

On Thursday night a dinner party was given at the Union Square Hotel.

On Friday morning a trip was taken about the bay on the U. S. steamer General Mifflin.

David Brian of Los Angeles was elected president for the ensuing year, succeeding Herman Nothig.

State Secretary W. T. W. Curl says that the Los Angeles association has 444 members, with prospects of rapid growth, making it the second in numbers in the United States. Chicago No. 1 is the largest, with over 500 members, and San Francisco has a total of 350 members in its two associations. There is no doubt that Oakland and Sacramento will both form associations soon after this convention.

TRADE NOTES.

The name of the "Pacific Miner" of San Francisco has been changed to "The Mining and Metallurgical Journal."

An order for two 1000-kw. synchronous motor-generator sets was recently received by the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., from the San Francisco Gas & Electric Company, of San Francisco, Cal.

The "California Derrick" of May 25, 1911, contains a valuable article by Paul W. Prutzman on "A Continuous Topping Plant," this being one of a long series of a discussion of the problems of oil refining by Mr. Prutzman and Professor Edmund O'Neil.

The Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., recently received from the Seattle-Everett Traction Company, Bellingham, Wash., an order which calls for a quadruple equipment of No. 304 railway motors with the new HL (Non-Automatic) Unit Switch Control.

ELECTRICAL CONTRACTORS MEETING.

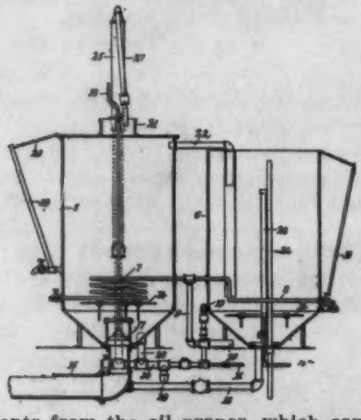
The electrical contractors of California are busy preparing for their State Convention, which takes place at Santa Catalina Island in July. A special rate good for thirty days has been obtained for the contractors and their friends. The contractors will be entertained by the Los Angeles contractors and will go into camp at the Island with quite a large body. There being in the California State Association of Electrical Contractors about 200 members, coming from San Francisco, San Jose, Sacramento, Stockton, Eureka, Oakland, Los Angeles, Palo Alto, Bakersfield, Fresno, Santa Barbara, Los Aangeles, Palo Alto, Bakersfield, Fresno, Santa Rosa and San Rafael. All members of the building crafts are invited to take advantage of the excursion; information can be obtained from officers. The officers are W. S. Hanbridge, San Francisco District; H. B. Woodill of Los Angeles, first president; F. V. Meyers, secretary; L. R. Boyton director for vice president; Carl Heilbron of San Diego, second vice president; John Rendler of Los Angeles, director for Los Angeles district and in charge of the entertainment.

PATENTS

993,427. Reinforced-Concrete Pole. Edward L. Williams, Igerna, Cal. A reinforced concrete pole comprising a plurality of sections, each section being composed of reinforced concrete and provided with an integral socket at one end and an integral concrete plug at the other end, a reinforcing ele-

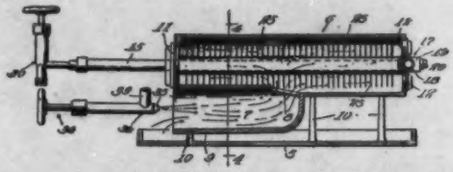
ment disposed longitudinally of the section and extending into said plug at one end and into the walls of the socket at the other end and looped back upon itself in said plug and in the walls of said socket, and means disposed through the integral plugs and sockets to lock the sections together to form an integral structure, substantially as described.

994,100. Process of Breaking up and Separating the Gaseous Liquid and Solid Constituents of Crude Petroleum. Linus W. Brown, Monrovia, Cal.: George Francis Brown and Daisy Lucretia Brown Condon, executors of said Linus W. Brown, deceased. The described process of treating the species of crude petroleum obtained from oil wells in the State of California, for the purpose of separating the solid liquid and gas-



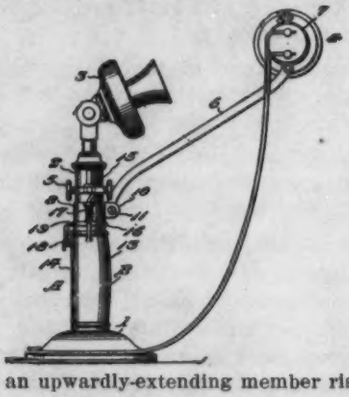
eous constituents from the oil proper, which consists in passing the crude oil in its emulsified condition along with steam through a common conduit, whereby they are thoroughly intermingled and the emulsion is broken up, and then allowing the steam and other gases to escape and discharging the solid and liquid products into a hot-water tank wherein the elements are completely segregated as described.

993,768. Liquid-Fuel Burner. James E. Dunkley, Los Angeles, Cal. A liquid fuel burner, comprising an elongated approximately cylindrical mixing chamber having logitudinal depressions in its outer side walls and having discharge slots in its outer side walls extending both above and below the depressions, the bottom walls of the depressions being imperforated, a mixing tube extending from one end to a point near the center of the mixing chamber along its under wall, the mixing tube extending slightly into the mixing chamber, a generating tube in the said depressions and adapted to form



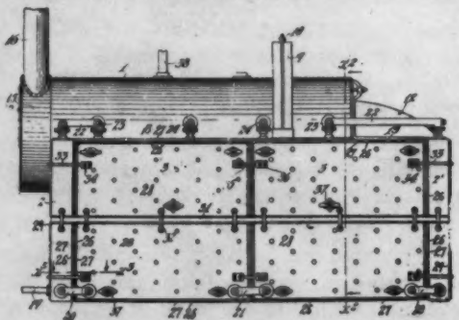
a passage around the sides and rear end of the chamber, an inlet valve adapted to control the admission of fluid to one end of the tube, means connected to the tube on the other end for injecting the generated vapor into the forward end of the air tube.

993,975. Telephone-Support. Charles E. Flynn, Vale Ore. The combination of a desk telephone set, a sleeve-shaped grip encircling and movable longitudinally of the handle of the



telephone, and an upwardly-extending member rising from the top of the sleeve and having means connecting with the receiver fork to actuate the same by the relative movement between the grip and telephone.

993480. Boiler. Samuel M. Walker, Los Angeles, Cal. A boiler comprising a cylindrical casing, a closed fire box formed of approximately rectangular hollow side and end sections, extending from the base to a point about half way up the sides and ends of the cylindrical casing, means for securing the side sections together, means for securing the end sections to the side sections, pipes and couplings connect-



ing the side sections, pipe and couplings connecting the end sections to the side sections, a supply pipe connected with the forward end section, pipes and couplings connecting the side and end sections with the cylindrical casing, an arched cover-plate resting on the top of the rear side sections and against the rear end of the cylindrical casing, and means for supporting the rear end of the cylindrical casing upon the rear side sections.

INDUSTRIAL

O-B THERMO BONDING PROCESS.

This is a simple, economical, rapid and effective method by which the terminals of standard O-B all wire compressed terminal rail bonds can be soldered to the rails after being compressed by the O-B compressor in the ordinary way, thus combining the great permanent conductivity afforded by soldering both head and stud of the terminal with the well-known mechanical strength and positive application obtained by compression.

obtained will be maintained without depreciating for an extremely long period of time under service conditions.

This filling in of the solder will remedy careless work on the part of the compressor gang where the bonds have not been compressed to the full extent (a not unusual occurrence) and thus make a permanently good joint out of the one that would inevitably soon lose all conductivity due to corrosion.

This process is equally effective for both new bonding and rebonding work.

Fig. 1. Ready for Ignition.

Fig. 2. During Reaction.

Fig. 3. Applying the Solder.

The extra tool equipment and materials required are simple and low in cost. The entire operation can be performed by one man in a very few minutes and it has been found possible to apply bonds by this process on roads having a two-minute headway without delaying the traffic.

The process consists of heating the bond terminal, after compression, and the adjacent web of the rail practically instantaneously, independent of cold or windy weather conditions, by a chemical reaction. The heat produced is so concentrated that while the terminal and the adjacent web are quickly brought to a soldering heat the ball of the rail remains so cool that the hand can be laid upon it while the soldering is being done so that no injury to the rail or to the body of the bond can possibly result. The solder enters at "C," Fig. 4, under the shoulder "B" of the terminal and firmly unites the entire shoulder "B" to the web of the rail, forming a fillet at "C" and thus positively sealing the joint against the entrance of moisture between the head of the bond and the web of the rail and uniting the compressed portions of the terminal to the annular walls of the hole in the rail.

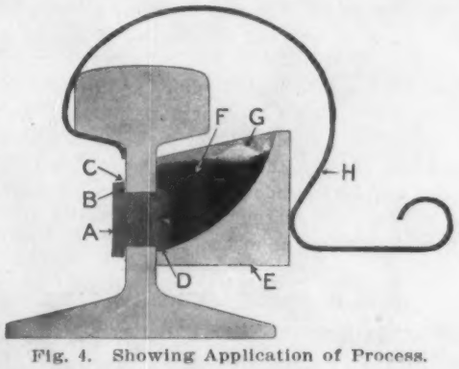


Fig. 4. Showing Application of Process.

The result is a greatly increased permanent contact area (B) and the positive sealing of the entire joint against moisture and corrosion so that the initial high conductivity thus

A number of the most expert bond men in the country have made trial installations, using this process, and have made tests extending over a long period of time of the results obtained as compared to compressed terminal bonding without this process and without exception the verdict has been that the increased permanent efficiency due to the O-B thermo bonding process is remarkable to say the least.

Complete instructions for using this process will be sent to proper parties on application and The Ohio Brass Co. of Marsfield, Ohio, would be glad to have their representatives make trial demonstrations on the tracks of companies who are in the market for rail bonds.

The Ohio Brass Co. has broad patents covering the process and its use is strictly limited thereby to the application of rail bonds furnished by that company only. The use of this process in applying bonds other than those supplied by The Ohio Brass Co. will constitute an infringement and be prosecuted by them as such.

NEW LUMINOUS ARC HEADLIGHTS.

The luminous magnetite arc which already has revolutionized street lighting systems is employed to great advantage in the new line of arc headlights for electric cars, developed by the General Electric Company. There are eight styles available, the different styles being specially designed to satisfy all the requirements and operating conditions obtaining in suburban, interurban and mining electric railways. All styles operate on the same principle, but differ in the details of construction and equipment necessary to furnish the character of illumination most suitable for the various classes of service.

The mechanism is arranged to maintain an arc of fixed length at the focus of the reflector, without requiring the motorman to make any electrode adjustments whatever. Furthermore, the well known characteristic of the luminous arc, to emit a reduced amount of light under reversed polarity of the electrodes, is utilized for dimming the headlights when operating within the limits of cities, towns and other populous districts. This feature is distinctly novel in the manipula-

tion of arc headlights, and completely eliminates the use of antiquated mechanical screens and other inconvenient methods.

It is recognized, however, that dimming by means of auxiliary incandescent lamps is satisfactory and preferred by some railway companies. Therefore, several styles are equipped with one or more standard 16 c.p. 110-volt incandescent lamps, connected in series with a suitable resistance for operation across the nominal railway potential.

The headlights for suburban cars operating on tracks having many curves and intersected by numerous roadways are equipped with parabolic reflectors of polished metal, for furnishing a broad fan of light which extends directly from the head of the car and 50 ft. on each side to a distance of about 1200 or 1500 ft. along the track. This character of illumination enables the motorman to see to some extent around curves, and also to detect the presence of pedestrians or vehicles approaching at right angles to the track. These headlights are provided with efficient heat resisting glass doors, which effectually protect the arc from draughts, and are equipped with spherical chimneys or shields for cutting off the objectionable side rays.

Where curves and intersecting roads are less numerous, and the cars operate at higher speeds, headlights equipped with mangin mirror reflectors are found very satisfactory. The mangin mirror furnishes a more concentrated beam of greater penetrating power than that of the parabolic reflector, and for satisfying the requirements of high speed suburban and interurban service it lies between the parabolic reflector styles and those equipped with semaphore lenses.

The latter are especially designed for high speed interurban cars operating on lines having long tangents. They furnish a brilliant beam of practically parallel rays, projected to a distance of about 2000 ft. ahead of the car. Since an interurban limited traveling at 60 miles an hour can be brought to a stop, by good braking, within a distance of about 1800 ft., these headlights afford an ample factor of safety at the highest probable operating speeds.

The semaphore lens is of the moulded plano-convex type. It consists of a series of circular sections arranged to give the best optical effect, and combines great strength with minimum weight. Its depth of focus enables it to be placed sufficiently far from the electrodes so that it is not affected by the heat of the arc. These headlights also, are arranged for in-town dimming either by the reversed polarity method, or by means of auxiliary incandescent lamps.

In all styles of headlights the positive electrode consisting of a stationary copper forging sheathed in a shell of non-oxidizable metal, has a life of 2000 to 3000 hours. The negative electrode, consisting of a tube of thin welded steel containing the mixture of iron oxide and other substances required for forming the luminous arc, has a life of 60 to 80 hours. The low rate of consumption of the electrodes serves to maintain the arc at the focus of the reflector and to keep it within safe voltage limits, without requiring the motorman to make any electrode adjustments. Furthermore, since the light of the luminous arc emanates from the entire arc stream composed of the highly incandescent vapors from the negative electrode, these headlights are much more efficient than those employing carbon arcs in which the source of light is limited to the incandescent tips of the carbons.

Unless otherwise ordered, all headlights are arranged to operate on a nominal railway potential of 550 volts with an 80 volt arc and a current of 4 amperes. The difference between the line and arc potentials may be controlled by resistances or by incandescent lamps. In the latter case the incandescent lamps can be acceptably utilized for lighting the interior of the car and the wiring can be easily arranged to permit of the interior lamps remaining lighted whenever the headlights are turned either on or off.

THE WESTINGHOUSE NURSERY MILK WARMER.

With the Westinghouse electric nursery milk warmer a bottle full of infants' food will be heated to the right temperature for the baby, in three minutes after the switch is turned on. Although intended primarily for heating infants' food, the milk warmer, without the bottle, can be used for heating or boiling any liquid and is convenient for heating water, for the sick room, for shaving, and for similar purposes. The water vessel holds about a pint and this quantity of water can be raised to the boiling point in about six minutes.

A heater of the Westinghouse cylindrical immersion type is used. When in use, the heater is wholly submerged in the water to be heated. All of the heat developed in the heater must, therefore, be transmitted to the water. The heating element (resistor) is hermetically sealed within the walls of the copper jacket forming the heater and is thus effectually protected against oxidization. The heater has an indefinite length of life if operated on normal voltage.

Exploded View of Nursery Milk Warmer.

By merely turning it to a position where a slot in the rim permits of its being taken out, the heater can be removed from the water vessel. All parts are accessible for easy cleaning as indicated in the illustration.

A nursery bottle and nipple of Hygia manufacture are supplied with each warmer. While being heated, the bottle sets in a water bath and in the cylindrical heater which, in turn, rests in the water vessel. The water bath is an important feature of the heater, as infants' food cannot be burned and thereby rendered indigestible if heated in a water bath.

A current tap attachment plug is furnished with each milk-warmer outfit. This plug screws into any Edison base lamp socket and has itself a lamp socket and a socket to accommodate the plug on the milk warmer cord. By using it, the warmer and an incandescent lamp can be operated from the same outlet. The warmer takes 500 watts and operates with either alternating or direct current.

NEW STORAGE BATTERY CARS.

The Electric Storage Battery Company of Philadelphia has closed a contract for the battery equipment of the 35 new storage battery cars for the Dry Dock, East Broadway & Battery Railroad Company of New York City to be placed in service on their lines during the early summer.

These new cars have been specially designed by the Third Avenue Railway Company to give the necessary strength with minimum weight. Each car is equipped with two motors and the batteries are installed under the longitudinal seats.

The cars will give a maximum speed of 15 miles an hour on level track with a schedule speed of seven to eight miles an hour including stops. They are of the open platform single truck type with 18-foot car bodies.

The battery equipment of each car consists of 58 cells of Type 29 MV "Hycap-Exide."

NEWS NOTES

FINANCIAL.

CHINO, CAL.—The City Council has passed an ordinance issuing bonds in the sum of $40,000 for the purpose of acquiring a complete municipal water plant and system.

SANTA PAULA, CAL.—The city clerk will receive sealed bids up to July 17 for a franchise to construct and operate for 30 years a conduit, main or pipe line along certain portions of streets and highways of the city.

SANTA BARBARA, CAL.—The City Council has sold $40,000 worth of municipal bonds to the Santa Barbara County National Bank for a premium of $233.50. The money is to be used in waterworks extensions.

RIVERSIDE, CAL.—A meeting will be held at the office of the Riverside Water Company on August 1, 1911, for voting on the proposition of issuing bonds in the sum of $750,000 for enlarging and perfecting the water system.

TROY, IDAHO.—The Council has passed an ordinance authorizing the call of an election in Troy for the purpose of authorizing the issuance of $12,000 in bonds to be used for the purpose of constructing a system of waterworks.

SACRAMENTO, CAL.—The City Board of Trustees has adopted a resolution clearing the way for calling an election for the purpose of voting bonds in the sum of $200,000 to purchase and install a new pumping unite for the city waterworks department. It is expected that the election will be held some time in July.

SAN FRANCISCO, CAL.—In a decision handed down last week by the Supreme Court, Los Angeles was given the right to issue bonds to the extent of $3,500,000 authorized by the vote of the electors April 19, 1910, for the purpose of building and maintaining its own heat, light and power company. An injunction obtained by Percy H. Clark, which had been decided in favor of the city and then was appealed to the Supreme Court, was dissolved when the Supreme Court sustained the verdict of the lower court, which had given judgment on a demurrer filed by the city attorney a year ago. Clark contended that the city had no power to engage in the enterprise projected, but the Supreme Court held this untenable, as an amendment to the Los Angeles charter in 1909 gave the power and the right to secure lands, water rights, machinery and all else needed. Clark also contended that the bonds would give Los Angeles an indebtedness beyond the fixed limit, but this also was overruled, the court decided, by a special amendment to the charter making provision for public utilities.

INCORPORATIONS.

HERMISTON, ORE.—The Hermiston Farmers' Exchange Telephone Company, capital $10,000, has been incorporated by W. H. Skinner, Geo. H. Cressy, et al.

SAN FRANCISCO, CAL.—California Land and Water Co., $25,000; shares $1 each, subscribed $500, by M. E. Miller, W. L. Wilson, E. G. Straub, H. Woods and O. S. Strain, 1 share each.

VANCOUVER, WASH.—The Washington Engineering & Securities Company, capital $3,500,000, has been incorporated by E. M. Scanlon and James P. Stapleton of this city, with the help of several New York capitalists. The intention is to operate all kinds of plants to distribute light and power, at this place.

McMINNVILLE, ORE.—McMinnville Mutual Telephone association, principal office, McMinnville, Ore.; capital stock, $1000.

LOS ANGELES, CAL.—Annex City Water Company, $75,000, subscribed $30, by B. G. Adams, E. H. Adams and W. C. Murray.

SAN FRANCISCO, CAL.—Perpetual Germ Proof Telephone Mouthpiece Co., San Francisco; $75,000, shares $1 each, subscribed $500, by E. J. Leiter, F. Rittigstein, J. L. Jannet, M. F. Rapp and W. M. English, 100 shares each.

STOCKTON, CAL.—Joaquin Delta Railway Company, Stockton, $500,000, subscribed $40,000, by E. W. and L. H. Woods, Frank West and E. L. Wilhoit of this city, W. P. Plumer, I. L. Borden and M. E. Cerf of San Francisco.

HALF MOON BAY, CAL.—Half Moon Bay Light & Power Company, Moss Beach; $25,000, subscribed $12,500, by J. J. Gomez, M. Codivo, Ben Cunna, Joe Fernandez and F. N. Staley. A power line has been surveyed from San Mateo under the direction of Sidney Sprout, consulting engineer.

ILLUMINATION.

CLARKSTON, WASH.—At the council meeting last week the Lewiston-Clarkston Improvement Company made application for a 50-year franchise for light and power.

LACROSSE, WASH.—Harry C. Wilson, proprietor of the Lacrosse chop mill and lessee of the local waterworks system, contemplates the installation of a 150-light 16 c. p. electric plant.

TULARE, CAL.—The Tulare County Power Company, C. H. Holly, manager, has made application for a franchise to establish and maintain poles, wires and other electrical appliances in this city.

SEBASTOPOL, CAL.—A contract has been entered into with the Neptune Meter Company to furnish the town with Trident No. 3 disk meters for one year at a cost of $8.60 for each meter.

LOS ANGELES, CAL.—The Southern California Edison Company has filed application with the war department through the Los Angeles United States engineering offices, for permission to erect a transmission line across Cerritos slough, west of Long Beach harbor. The company agrees to maintain the cable on towers at least 140 feet above the water.

SAN PEDRO, CAL.—Plans for a new light and fog signal station to be built at end of the breakwater are now completed and work on the new structure will begin shortly after July 1, at which time the appropriation of $36,000 made by congress for it will be available. Plans call for a structure of reinforced concrete and boiler plate. The equipment will consist of flashing light and fog siren, the light to be visible for eighteen miles.

MEDFORD, ORE.—That the Siskiyou Light & Power Company will bring their power line from the Fall Creek plant to Ashland and distribute current in the Rogue River Valley in connection with the Condor Power Company is now certain. Engineer Harvey J. Sarter has finished the Ashland end of the permanent survey and Engineer John C. Boyle will complete the Fall Creek end this week. General Manager Orlo G. Steel was in Ashland several days last week arranging for the immediate construction of the line. The first work is

the clearing of a 75-foot right of way. The line avoids the heavy timber and the distance between Ashland and Fall Creek is 23 miles. Mr. Steel states that 200,000 pounds of No. 2 copper wire and 5000 insulators are en route from New York. Red fir poles 44 feet high and 7 inch tops have been ordered and they will be put on top of concrete bases. The line will be of special wooden tower construction, 10 towers to the mile. The transmission line will carry current at 60,000 volts. The power line will cost approximately $50,000 though other expenses connected with it will require an additional $25,000. When completed it will tie into five different plants operated by subsidiary companies, affording opportunities to fall back on in case of emergencies. The line will be connected with the Ashland Electric Light & Power Company's plant in Ashland in the fall.

TRANSMISSION.

PALA CEDRO, CAL.—Sixty tons of freight lies here awaiting shipment to the Northern California Power Company's power plant at Kilarc, near Whitmoore. The plant is to be increased from 5000 h.p. capacity to 8000 h.p.

LEWISTON, IDAHO.—It is reported that the Lewiston-Clarkston Improvement Company will in about a year erect a sub-station east of the city and rebuild the high power station line serving the city. It has been announced that the company is laying plans for the development of their power site on the Grande Ronde river.

CONCONULLY, WASH.—A franchise has been granted to J. C. Morton for the construction of an electric light plant and waterworks. Work will start at once on the electric light plant and waterworks system which will be completed at the expiration of the year. Both plants will cost $10,000. The electric plant will at present be operated with steam, later water power will be used.

VANCOUVER, WASH.—Fire of unknown cause originating in the boiler room totally destroyed the Vancouver power plant of the Portland Railway, Light & Power Company on June 4, causing a loss of $63,000; insurance, $35,000. Little inconvenience was caused consumers of light and power, the company placing in use an emergency cable, bringing current from the Portland plant.

MANTON, CAL.—Chadwick & Sykes the contractors who were to finish the Colman ditch, have turned the work back to the Northern California Power Company. A. H. Clough, the civil engineer for the company, will take charge of the work again. The Colman power house is completed, and all the machinery has been installed, but the ditch will not be finished before the first of the year.

SAN FRANCISCO, CAL.—Architect Willis Polk is now preparing the plans for a reinforced concrete power station which is to be erected for the San Francisco Gas & Electric Company on Bush street, near Larkin. The new building will be used as a substation for the company's power distribution. The cost of the work has been estimated at $15,000. The plans will be ready for figures in a short time.

BODIE, CAL.—The plant of the Pacific Hydroelectric Power Company, at Mono Lake has been completely restored and power is again being furnished cities of Southern Nevada. This plant was destroyed last March by snowslides, which tore away the power plant and lines and caused the death of several people and injury to others. The plant supplies power and light to Bodie, Lucky Boy, Aurora, Rawhide, Fairview and other camps in Nevada.

VICTORIA, B. C.—Bids will be received by W. L. Coulson, general manager of the Canadian Collieries, Ltd., up to June 26 for furnishing and installing two direct connected hydro-electric units at the company's power house at Comox, B. C. Bids will be received on the same date for construction work necessary on the installation of hydroelectric power on the Puntledge River, Comox. Work to embrace clearing, construction of dams, flume, pipe line and power house.

OROVILLE, CAL.—County Recorder J. A. Tyler is in receipt of an order from C. D. Marx, chairman of the State Board of Control of Water Power, instructing him not to record any more water right locations and requesting a copy of all location notices filed in the Recorder's office sixty days prior to and sixty days after the new conservation measure went into effect. During the last winter, while the waterpower measure was pending before the California Legislature, representatives of the Great Western Power Company and the Oro Light & Power Company forestalled the action of that body by filing on hundreds of thousands of inches of water in the North Fork watershed. These filings, with others, aggregated in the neighborhood of 800,000 miner's inches, and having been made prior to the bill becoming effective, it is not thought anything can be done in the matter. The new law approved April 8th places all water rights under the supervision of the State Board of Control in Sacramento.

PORTLAND, ORE.—The Pacific Power & Light Company, already owning and operating about 90 public utilities in the Pacific Northwest, is approaching the local field in its sphere of influence. Through as associated corporation, the Electric Bond and Share Company, of New York, it has just organized and incorporated the Washington Engineering & Securities Company, with headquarters at Vancouver, Wash. It is capitalized at $3,500,000, divided into 35,000 shares of $100 each and its charter allows it to operate all kinds of industrial plants and to engage in the distribution of light and power and to operate electric transportation lines. This is the first move this syndicate has taken toward getting a foothold in the immediate vicinity of Portland. It owns the street railway, electric light and gas plants at Astoria and practically controls the entire public utility fields of more than a score of cities in Eastern Oregon and Washington. The new syndicate will come as a strong factor in the Vancouver field which is already being served by the Portland Railway, Light & Power Company and the Mount Hood Railway & Power Company. These corporations control all the public service franchises which have been granted by the Vancouver Council and so far as is known the new concern has not shown its hand as to what its intentions are toward further exploitation of that field. It is known, however, to have unlimited Eastern capital behind it.

TRANSPORTATION.

TACOMA, WASH.—Frank E. Ross of this city announced that preliminary plans have been completed for the construction of an electric railroad from Gig Harbor to the Straits of Juan de Fuca. Survey has been completed and part of right of way secured.

PORT ANGELES, WASH.—Various commercial bodies of the Olympia peninsula will meet here and discuss plans for the organization of a company to construct an electric railway from Lake Crescent through to Hoods Canal, via this city.

OAKLAND, CAL.—Sixty pay-as-you-enter cars will be put into service by the Oakland Traction Company within the next month. The new cars, which will resemble those being used by the United Railroads in San Francisco, are on their way to Oakland from the car shops in St. Louis, and are expected here within three or four weeks. They will be put into service on the various lines immediately upon their arrival. No announcement has been made as to which lines the cars will be put into service.

WENATCHEE, WASH.—The City Council will probably grant a franchise to the Wenatchee Traction Company at their next regular meeting, permitting the company to operate an elecric line in this city.

BERKELEY, CAL.—Announcement was made that the Oakland Traction Company will start at once on the double tracking of its Northbrae line, from University and Grove to the southern boundary of the Spring estate.

HAYWARDS, CAL.—The Board of Trustees has adopted an ordinance granting I. B. Parsons, and his assigns a franchise to construct and operate for 30 years, a single or double track, standard gauge railroad by electric or any other than steam, animal or cable power, over and across certain streets in the town of Haywards.

RIVERSIDE, CAL.—The City Council has received a formal request from the Pacific Electric Railway Company for a franchise for an electric line over Magnolia avenue. The city attorney was instructed to draw up a franchise covering the thoroughfare.

RAYMOND, WASH.—Ray Fulcher, construction engineer for Sanderson & Porter, the New York engineering concern controlling the Grays Harbor Electric Company, is here preparatory to assembling a crew to inaugurate construction work on the Raymond-South Bend electric line. It is probable that other electric lines to tap agricultural and timber lands will follow.

NAPA, CAL.—Announcement is made by Superintendent M. McIntyre of the San Francisco & Napa Valley Electric Railway, that the line will be extended to Calistoga in the immediate future. The company has already begun the erection of a bridge across York Creek, at the present terminus of the line at St. Helena, and as soon as the steel arrives from the East the construction of the track north to Calistoga will commence. The improvement was made possible by the recent reorganization of the road, when a new $1,000,000 bond issue was authorized.

MODESTO, CAL.—Six carloads of ties have arrived in Modesto and were consigned to the Tidewater & Southern Railroad Company, which is building an electric line from Stockton to Merced, passing through this city. The campaign for subscriptions for the purchase of bonds has progressed to such an extent recently that the officials of the road are now confident that the line will be in operation before the close of the year. The Board of Trustees of Modesto has granted a franchise to the company for a right of way along Ninth street, running parallel with the Southern Pacific line.

WATERWORKS.

LOS ANGELES, CAL.—The Department of Public Service is receiving sealed bids for furnishing fire hydrants to the city.

NORTH YAKIMA, WASH.—Water main extensions have been decided on by the officials of the Pacific Power & Light Company.

SAN DIEGO, CAL.—The Department of Finance, Ways and Means is receiving sealed bids for furnishing cast iron water pipe to the city.

ESCONDIDO, CAL.—The Directors of the Escondido Water Company have rejected bids submitted for furnishing supplies to the company.

VANCOUVER, WASH.—The Washington-Oregon Corporation, which controls the water and gas plants of this city, plans $400,000 improvements to the same.

TACOMA, WASH.—Fifteen bids on the final unit of the Green River gravity water system have been received by Commissioner of Light & Water Nicholas Lawson. P. E. McHugh of this city submitting the lowest bid.

PASCO, WASH.—The contract for furnishing the pipe for the water system for Sylvester's Addition has been awarded to the Washington Pipe & Foundry Company of Tacoma.

PASCO, WASH.—An ordinance has been passed by the council authorizing the city attorney to institute condemnation proceedings against the Pacific Light & Power Company for the purpose of acquiring the waterworks system.

PORTLAND, ORE.—Bids will be received by the Water Board of Portland to June 13th for furnishing 200 fire hydrants f. o. b. cars, Portland, Ore. Specifications to be obtained at the office of D. D. Clarke, Engineer of Water Board.

CORVALLIS, ORE.—Engineer Miller of Seattle, the designer of the mountain water system of this city, has developed a plan for improving the intakes to prevent clogging in time of high water. Superintendent Strange will take personal charge of the construction work.

TACOMA, WASH.—Bids are being received at the office of the commissioner of Light & Water, City Hall, Tacoma, Wash., for furnishing and delivering all materials and for the construction of water mains in local improvement district No. 573, according to plans and specifications on file.

HAINES, ORE.—The $20,000 bond issue providing for a municipal water system, has been sold and a contract for the entire system with the exception of drilling the well, has been awarded to G. H. Sutherlin & Co., of Walla Walla, for $15,453. Thos. Leffler of Haines was awarded the contract for drilling the well.

PORTLAND, ORE.—A 12 inch main will be laid on East Water street before the pavement is laid down, and large mains will be laid on East Third street and Union avenue, East Oak and East Salmon streets. Paquet, Giebisch & Joplin have submitted the lowest bid for laying the large cast iron main on Lincoln street from East Sixteenth to Marguerete avenue to supply the high service direct from the new reservoir.

OAKLAND, CAL.—W. F. Kelly, up to May 1st general manager of all the lines of the Oakland Traction Company and the Key Route system properties, in which F. M. Smith, the "borax king," is greatly interested, is now a director of the People's Water Company, of which Frank C. Havens is president. Kelly was elected to the office at a meeting of the board of directors May 18th, his name being proposed to fill the vacancy left through the resignation of George N. O'Brien of Berkeley.

SPOKANE, WASH.—W. A. White, chairman of the finance committee of the Washington Water Power Company, Spokane, Wash., has outlined as follows work to be undertaken by the company at Spokane: Large amounts of money have been provided to develop the large power station at Long Lake and the Spokane & Long Lake Railway and to complete the Little Falls plant, purchase additional cars and equipment, extend the local distributing lines within the city, install storage batteries, extend the underground conduit system and complete the transmission line from Post Falls.

TACOMA, WASH.—The Council has adopted a resolution providing for placing a 6 inch cast iron water main on Carr street, from Yakima avenue to North Thirtieth street, according to plans and specifications to be prepared by the Commissioner of Light and Water. The Council has also adopted a resolution providing for the construction of 8 inch wooden water main on South Sixty-sixth street from Huson street to Orchard street, a 6 inch wooden water main on South Sixty-second street from Ferdinand street to Orchard, and a 6 inch wooden water man on Huson street and Orchard street, from South Sixty-second street, to South Sixty-sixth street, according to plans to be prepared by the Commissioner of Light and Water.

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